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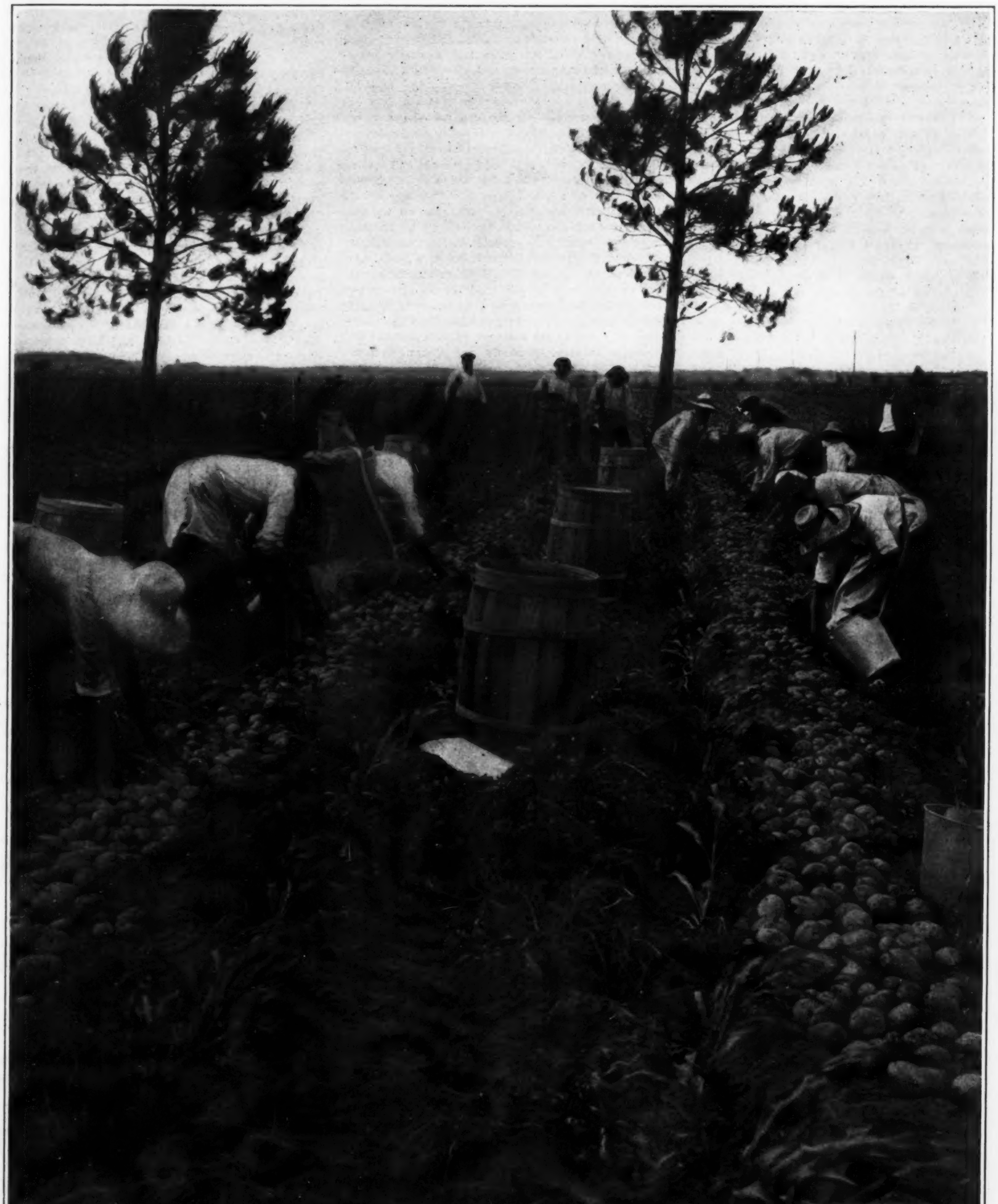

Photo by the Gilliams Service

Gathering and Sorting Potatoes on a Florida Plantation

SPUDS BY THE MILLION [See page 196]

The Variations of Present Day Glaciers*

A Discussion of Theories Relating to Their Mechanism and Movement

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In the autumn of 1913, of 100 glaciers in the Swiss Alps, 33 were increasing, 8 stationary, and 59 decreasing; in 1916 there were 64 increasing, 8 stationary, and 28 decreasing.[1] At a moment, therefore, when the Alpine glaciers, which had been steadily decreasing for 25 years, at last present unequivocal symptoms of the beginning of an increase, it is fitting to strike a balance regarding our knowledge of one of the most attractive, and also most difficult subject of glaciology: the variations of glaciers.

A glacier occupies a certain disposition upon the surface of the earth: this varies with time, and it is this variation which is understood in general by *variation of glaciers.* The idea should, however, be defined with precision, and such defintion will be made in the course of this exposition. Let us observe at the outset that two sorts of glaciary variations must be distinguished: accompanying the great pluri-annual fluctuations which will particularly engage us, and whose most important terms are spaced by fractions of a century, or even by centuries. We note the existence of changes of the dimensions of the glacier corresponding to the rhythm of the seasons and, consequently, annual. Measurements of the Rhône glacier from 1887 to 1910, while the glacier was losing ground each year, shed a complete light upon this variation. It is proven by the monthly controls of the position of its front that the glacier is elongated each winter, while the predominating ablation of the warm season shortens it. This abbreviation has been 21.8 meters on the average, while the winter elongation has attained only 2.7 meters. The tracing of the successive positions of the front resembles, therefore, the teeth of a saw. Baltzer and Stump have obtained analogous results on the lower glacier of the Grindelwald.

Moreover, this seasonal variation does not differ in nature from the pluri-annual variations. Let us proceed, therefore, to the latter. Nothing can give us a better idea of them than the chronological table of the fluctuations of the glaciers of the Grindelwald, as preserved for us in the chronicles. The following is a résumé:[2]

1540. The two glaciers of the Grindelwald have withdrawn high up in the rocks.

1575-1600. Very great increase.

1600-1602. The glaciers are at their historic maximum of extent. The upper one covers the bed of the Bärgelbach; the lower one extends past the Burgbühl and comes within a stone's throw of the ravine of the Schüssellauenen. It has destroyed the chapel of Sainte-Pétroville on its left bank.

1602. The glaciers begin to decrease.

1620. The lower one is still not far from its most advanced moraine. It is almost in the state in which it is represented in the oldest known drawing of an Alpine glacier, that of Joseph Plepps: *Abildung des Gletschers im Grindelwaldt in der Herrschaft Bern* (Picture of the Grindelwald Glacier in the dominion of Bern), executed about 1638, engraved in 1642 by Utérian of Bâle. Chalets are pictured in it *mit welchen uran dem Gletscher hat werchen müssen;* which it was necessary to put beyond the reach of the glacier.

1661-1686. Important recession.

1703. New extension.

1720. New recession.

1743. New thrust.

1748-1779. New extension. The harvests were retarded by it in the vicinity of the glacier, and recourse was had to the exorcisms of the Capucine monks of Sarnen.

1819. The two glaciers which had been receding since 1779 are greatly extended, but have not reached, however, their 1602 moraines.

1820. Recession.

1840-1855. New increase, but slighter than the preceding.

1855. Recession.

1881. Growth of upper glacier; the other remains stationary.

1898. Decrease.

1903. Slight increase of upper glacier.

1907-1910. Slight increase of lower glacier.

1912. Increase of both glaciers.

1916. Increase of upper glacier; decrease of lower.

I have given this table at length because there is scarce any more complete in existence; but everywhere that glaciary variations have had economic consequences for the mountaineer such documents are to be found. The sagacious French glaciarist, P. Mougin[3], warden of streams and forests at Valence, has collected similar records for the glaciers of the *massif* of Mont Blanc debouching in the valley of the Arve.

What the chronicles of Grindelwald and the archives of Chamonix tell us is repeated in records and recitals through the whole extent of the Alpine chain. Now it is the relation of a catastrophe, provoked, here, by the unexpected extension of a glacier, there, on the contrary, by its extreme recession; again, it is the tradition of a previous state of such extreme deglaciation that passes in the high Alpine chains were made available where today the ice forbids their use. Thus in the sixteenth century it is said that people often passed Fiesch to Grindelwald by way of the glaciers, to carry there for baptism Protestant infants born in Valais; in the same way at the same period it is reported that intercourse between Chamonix and Courmayeur was carried on by the Col of the Géant, then more free of ice. These are mere traditions, doubtless, and must not be accepted without reserve, yet they are worthy of interest. As for the floods of water from the glaciers of the Ruitor in 1594, of the Glétroz in 1595, of the Vernagt in 1599; as for the falling in of the glacier of Bies upon Randa in 1635, and many other catastrophes occasioned either by the extension or by the excessive recession of the Alpine glaciers, they are incontestable facts.

Since the systematic observation of the glaciary apparatus, inaugurated by Forel in the Swiss Alps thirty-seven years ago, has been extended throughout the entire globe by the creation in 1894 of the International Commission of Glaciers (C. I. G.), innumerable observations, collected in the ice-covered regions of Alaska, of Greenland, of New Zealand, as well as in those of the Alps, the Pyrenees, and Scandinavia, have confirmed both the universality and the extreme complexity of the phenomena of the variation of glaciers. It would be as idle as tedious to accumulate here the numerical data: the reader would be submerged by them. I will refer him therefore to the special publications and to the reports[4] wherein the activities of the International Commission have been condensed for the last twenty years. I will attempt rather to disengage from the formidable mass of documents certain ideas which will serve as guides.

If this mass has been greatly enriched since Forel attempted, at the end of the last century, to determine the laws of glaciary variations, our positive facts, on the other hand, have become fewer and more wavering than ever. To the simplicity and the premature rigidity of his pronouncements of 1900[5] Forel himself opposed in 1911[6] the accepted flood of altogether general assertions. Certain notions remain to us, however, as stated below:

Since chronology indicates practically the same epochs for the maxima of extension of the glaciers of the Alps, it has been believed that we might accept the simultaneousness of the increases and the decreases of all the glaciers of a vast region; but in making precise the dates of the appearance of these phases in the various glaciers, it has been necessary to note that each apparatus oscillates according to its own rhythm, follows its own régime. "The behavior of the various glaciers is individual. One glacier lengthens while its neighbor remains stationary or decreases," wrote Forel in 1911.

This is verified even by glaciers very close together. We see, for example, in 1914-1915, the great glacier of Aletsch recede 6 meters, while that of the Fiesch, quite nearby, advances 11 meters. In the little *massif* of the Diablerets (Vaudoise Alps), the icy sheet of the Scex-Rouge gains 5 meters in length, while the front of the Prapioz loses 4. Still more, from 1896 to 1901, when all the glaciers of the Valois under observation were receding, the little glacier of Boveyre (massif of Combin) continued steadily to grow.

We need not be influenced, however, by these typical examples, though they are easy to multiply, to reject all idea of generality in the direction of the variation. The cases cited above represent, in fact, a period of slight fluctuations. History teaches us, on the contrary, that the great Alpine extensions at the end of the sixteenth century, at the beginning and then in the middle of the nineteenth century, were universal; all the glaciers of the Alps had a maximum between 1810 and 1825, and another towards 1855, after which they all receded. Only the epochs when they began to progress and of their maximum of extension differ a little from one system to another. Thus the precocious increase of the Bossons began in 1812 and did not come to an end till 1818, while that of the glacier of the Tour, begun tardily in 1817, had already stopped in 1820. The Hinterreisferner (Tyrol) had its maximum in 1818, its immediate neighbor, the Vernagtferner, not until 1822.

In the same manner the recession was general in the Alps during the second half of the nineteenth century. The glacier of the Rhône,[7] to cite only this celebrated system, decreased incessantly for fifty-seven years, losing nearly 1,000 meters of its length, leaving bare more than 106 hectors of terrain, and losing some 200 million cubic meters. But upon this general and accentuated tendency of retrogression there has been superposed since 1875 a slighter tendency towards growth, which, appearing first in the Chamonix region, took possession successively of the central and then of the eastern Alps. This growth affected some 200 glaciers, until 1893 as concerns the Swiss system, and the Austrian till 1901.

Let us observe, by the way, that this propagation of growth from the west to the east of our Alps is very well worth our interest.

Thus we recognize in the phenomena of glaciary variations at once general tendencies and individual manifestations. That is to say, unless, possibly, the glaciers react, each in its own manner, to some remote general action. And can one be astonished, therefore, that in comparing the variations of systems of very distant regions, we fail to detect any simultaneousness in their modes of action. The Scandinavian glaciers, *e. g.*, underwent in the eighteenth century the greatest increase ever recorded of them, and while in 1906-7 recession was the rule in the Alps, a state of increase was evident in Norway. The remarkable memoir of Charles Rabot[8] on the variations of arctic and boreal glaciers confirm this independence, as do also the International Reports.

The territorial glaciers, therefore, present themselves definitely as an ensemble of instruments, anolgous in construction and function, but diversely sensitive and diversely prompt also to react to the varied impulsions of the element which sets them in action, an element in which we can perceive nothing other than the climate, which is indeed the very condition of the glacier's existence. But before discussing here the modalities of this reaction, let us recall that the glacier stores up solid precipitations and surrenders them, liquified, to the general circulation of water at the end of a period which varies with the form, the dimensions and the geographic situation of the system. Its upper part, the *névé* or collector, receives more frozen matter than it can cause to disappear by ablation; its lower region, the *dissipator*, to speak precisely, dissipates more than it receives. The boundary of the *névé* separates these two domains. In the regions hav-

*Translated for The Scientific American Supplement from *Revue Générale des Sciences* (Paris).

[1]*The Periodic Variations of the Glaciers of the Swiss Alps.* Annual reports founded by F. A. Forel. 34th Report (1913), by Mercanton and Muret; 37th Report (1916), by Mercanton. *Annuaries du Club. Alpin Swisse* (Annual Reports of the Swiss Alpine Club) for 1914 and 1917. Berne, Stämpfli & Co.

[2]Studer: The Pastor's Book of Grindelwald. *Annuaire du C. A. S.*, 1880, and "Reports" of Forel (cf. 1).

[3]French Minister of Agriculture. Service of the great hydraulic forces. P. Mougin: Glaciologic Studies, vol. III: Savoy, 1912.

[4]Reports of the International Commission on Glaciers, 1894-1907, in the *Archives des Sciences physiques et Naturelles of* Geneva; 1905-1913 in the *Ann. de Glaciologie* of Brückner. In Commission at Georg's, at Geneva.

[5]F. A. Forel: The Periodic Variations of Glaciers. Coire, Casanora, 1900.

[6]F. A. Forel: The Periodic Variations of Glaciers. *Bibliothéque Universille*, Dec., 1911. Lausanne.

[7]Mensuration of the Glaciers of the Rhône, 1874-1915. Edited by P. L. Mercanton for the Swiss Commission on Glaciers. *Nouveaux Mémoires* de la Société Helvétique *des Sciences naturelles*, vol. III, 1916. In commission at Georg's, Geneva.

[8]Ch. Rabot: Variations of the Length of Glaciers in the Boreal and Arctic Regions. *Arch. des Sc. phys. et nat.*, 1897, 1899, 1900. Georg & Co., Geneva.

ing an Alpine relief the dissipator, contracted into narrow valleys, stretches out towards the fore part a strip or tongue of ice ready to reveal by marked retreats or extensions the slightest changes in the economy of the glacier.

The idea must impress itself at the outset that the glacier repeats in its own fashion the combined variations of the two factors which regulate this economy, *i. e.*, snowfall and ablation; in other words, precipitation and atmospheric temperature. In fact, one attempts at once to establish the desired parallelism between the glacial variations and the climatic periods whose existence seems to be established. Moreover, one is soon convinced that the undecennial period of Wolf, which marks the rhythm of solar activity, is not concerned. Forel and Richter thought to have happier results with the climatic cycle mentioned by Brückner[9] which governed the succession of hot and cold years, humid and dry ones, according to an average periodicity of 35 years. The first attempts were favorable. Between the maxima and the minima lengths of Alpine glaciers there were found intervals of 30 to 50 years whose average approximated the duration of the cycle of Brückner. But the doubt soon arose: is not this a mere matter of coincidence? Even Brückner's cycle appears to be justified in but precarious fashion; it is necessary to distinguish first between the dry or humid periods and the hot or cold periods. There is no synchronism between the maxima of precipitation and those of cold, between the maxima of drought and those of heat. The two factors of the glacial economy, alimentation and dissipation, do not collaborate, therefore, in strict accord. Moreover, a duration of 35 years is not an average pertaining to which deviations are apt to be very marked. Finally, Forel and Hellman have proved that if the period held true the phase of it changed from one locality to another, even in Europe. In order to suppose, therefore, that the glacier betrayed climatic variations with irreproachable mechanical fidelity, far more would it be necessary that the variation revealed should appear simple on examination. But it is precisely at this point that the factor of accuracy intervenes, and with such a degree of importance that Brückner himself renounced the idea of making use of the variations of length in glaciers in his investigation of the presumed variations of climates. The question therefore is still pending. It is proper, however, to cite a result singularly favorable to the applicability in the character of the Brückner cycle: the chronology of the Savoyard glaciers indicates, for 284 consecutive years, an average periodicity of $35\frac{1}{2}$ years; the great maxima of the Des Bois Glacier are at intervals of $106 = 3 \times 35.3$ years (1610-1716-1822). Note, however, that these intervals may vary from 105 to 118 years (Mougin[10]).

Let us observe now the mechanism of the variation of the glacier. Forel wrote in 1900: "The variations of glaciers are changes, not of form, but of volume." This pronouncement demands formal reserves; since the sudden progression of the Vernagtferner (Oetztal, Tyrol) at the end of the 19th century, provided Glaciology, by means of the marvelously sagacious mind of a Finsterwalder, with a singularly clear picture of the phases of the growth of the glacier, one must reject so absolute a judgment.

We can conceive today, in fact, of a variation which does not accompany any change of the volume, i. e., also of the mass, of the glacier, so far as a pluriannual variation is concerned. This would be the case in a glacier in which the ablation continued to shorten the dissipator in the summer, while the winter accumulated equivalent masses of snow in the collector. The glacier would not cease to recede, without, however, changing its volume. But we remark at once that such a variation of length would inevitably, and very shortly, be followed by a variation in the opposite direction.

It is necessary to say, therefore: "The variations of a glacier are changes of form *and* of volume."

For the change of form is characteristic of variation of the glacier. One need only have observed the same glacier increasing and decreasing to retain a faithful memory of such a change: the more the glacier which shrinks between its banks is underminable with its narrowed front, nearly always overflown by a thick layer of morainic pebbles, the more boldly does the growing glacier, overfed, rear upon the newly conquered terrain a dominating and convex front. And while its congener, emaciated, offers to the eye a united surface, but little cracked with a few crevasses and streamlets easy to cross, the growing glacier is barbed with pinnacles, rent by crevasses, and almost impassable. This is the aspect dear to artists and lovers of the picturesque. It is indeed difficult to imagine a more impressive spectacle than this bluish translucent mass advancing and overwhelming without haste, but implacably, all obstacles. In February, 1916, I saw the upper glacier of the Grindelwald, in a crisis of growth, demolish the foundations of a chalet in an invasion which, while irresistible, was yet so slow in its regularity that the carpet of snow spread before the glacier wrinkled without tearing like a rumpled cloth.

In itself alone this change of aspect of glacier indicates that the increase and the decrease represent two different regimes of the glacial flow.

As far as concerns the decrease, nothing could be more obvious: the ablation is superior to the afflux of frozen matter, the dissipation to the alimentation. The mechanism of increase is in general far more complex. While, to be sure, it is only a question of a frozen mass extended on all sides upon a comparatively united terrain, we easily conceive that in the same measure as its frozen material is augmented, the mass must thicken and extend itself while preserving practically the same form. But the very great majority of glaciers occupy, on the contrary, accentuated depressions of terrain, scooped out *cirques* prolonged into narrow valleys, and the longitudinal profile of their beds is usually terraced. The increase bears, therefore, the character of a complicated deformation of the whole body of the glacier, of the collector as well as of the dissipator. We can no longer believe, as did our ancestors, that glaciers sprout from the earth like mushrooms.

A fortuitous event, observed and interpreted with rare happiness by Finsterwalder, Hess[11] and Blümcke, has thrown a decisive light on the mechanism of the growth of glaciers, i. e., the forward thrust of the Vernagtferner from 1898 to 1902. This glacier occupies the bottom of a lateral valley of the Rofental conjointly with the smaller Guzlar glacier. It has a very extensive névé and a tongue usually narrow and short, but which has frequently presented, in historic times, sudden elongations of an amplitude absolutely exceptional in the glaciers of the Alps.

In 1889 the two glaciers still met under the Hintergrassisspitze. In 1895 the Vernagtferner, shrunken, was completely separated from its companion, but measurements already revealed at the foot of the tongue a peculiar swelling of the body of the glacier. Two years later the front had again receded, but already in the rear the intumescence had become visible to the naked eye. In 1898, while the névé continued to subside the swelling had reached the front and the latter had advanced 200 meters. At the same time the front had bulged, torn in every direction by crevasses, more than 100 meters in length, and more than 70 meters of ice-covered ground which had been entirely free the year before. This state of increase reached its ultimate development in 1900. In 1901 the glacier became again passable. In 1902 the increase came to an end; it had brought the front to about 420 meters in advance of its initial position, and the width of the glacier had passed from 300 meters to more than 500.

The interest of these observations is increased by what we have been able to observe of the displacements of a line of stones placed across the glacier, at one kilometer above its front, and at an altitude of 2,800 meters, almost at the root of the tongue. It thus became possible to measure by means of these ranges the speed of the flow of the glacier. From 1889 to 1891 it was, on the surface, only 17 meters per year; it increased, slowly at first, then with constantly accelerated speed, until it reached 280 meters in 1899—a year of maximum value, after which it fell to 208 meters in the year 1900. It increased to 220 meters in 1901, and it was then believed that a new thrust was about to be produced, but such was not the case; in 1902 the speed was not more than 74 meters, and in 1903 only 60.

The maximum length of the glacier had been retarded during three entire years of the maximum of speed in this section.

The intumescence was, therefore, propagated from the rear to the fore at a ratio of 240 meters per year, and had reached the front in 1898, while in the transverse profile the superficial speed was not over 177 meters per year. *Therefore the wave of intumescence was propagated faster than the glacier flowed*, and we have here an instance of a deformation of the mass correlative to its transport, but moving forward faster than the ice itself.

This result is of capital importance. It demonstrates a possibility which glacierists suspected, but which they dared not accept absolutely, i. e., that the flow of the glacier is not continuous in general, but rather[12] by fits and starts. The collector, gradually filled, empties itself by more or less sudden and energetic jerks, and when this evacuation is important the tongue of the glacier pressed forward from the rear by the masses which leave the upper reservoir, undergoes deformation and swelling; an undulatory intumescence, a wave of deformation, then descends rapidly along the course of the glacier and, at the moment when it reaches the front of the glacier, pushes the latter forward. At the same time the glacier widens itself on the passage of this wave, and in the great composite glacial sheets, like those of the Spitzberg, for example, one sees the increasing affluent crowd together the median moraines which separate it from its companions, impressing upon them inflexions which upon first examination are disconcerting.

We conceive that, according to the form of the glacier, the relative extents of the two portions, the collector and the dissipator, and finally, the declivities of its bed, the evacuation of the névé may be more or less tardy and also more or less incomplete. In the same way we understand that glaciers react individually to variations of climate.

Our nivometric[13] controls in the glaciers of the Trient, of the Grindelwalderviescherfirn, and of the Diableret confirm the belief that a collector may fill itself gradually during a period of several years, and afterwards empty itself abruptly in the course of a few months. I proved the fact in 1911, and still more recently, from September, 1916 to September, 1917, that the borders of the collectors of the Trient (3,100 meters) and of the Diableret (3,000 meters) are shrunken respectively by 3, 5 and 4.5 meters. This behavior movement of the glacial flow is explained by the properties of ice. When, under a definite pressure, the flowing of this substance has begun, there remains only considerably smaller pressure to continue the movement.

But the more abrupt and the more accentuated the change of section imposed upon the flux of the flow in its passage through the collector's orifice of discharge, the more difficult it is for the flow to establish itself (Hess[14]). It is thus explained, therefore, why such a glacier should be, by reason of its conformation, incapable of reacting to a climatic variation which has already affected its more sensitive neighbor; in the same way we conceive that all glaciers will finally obey, sooner or later, a climatic variation which is strong, and particularly one which is persistent.

The remarkable increase of the glaciers descending in the bay of Yakutat[15] (Alaska) came at an àpropos moment to support these views. In 1899 a violent earthquake shook the high peaks which surround the bay, caused enormous masses of névé to lose their equilibrium, and precipitated them in avalanches on the lower glacial sheets. Then a violent forward thrust of the fronts manifested itself in a striking succession: *the longer the glacier the tardier the increase.*

The complete mathematical theory of glacial variations has not yet been made. It has been outlined by such men as di Marchi[16], Reid and Finsterwalder.[17] The latter, in considering a glacier in two dimensions, length and thickness, and by the use of certain simple hypotheses upon the regime of variations of the section of the passage of the ice from the collector into the dissipator, has succeeded in giving an image of the changes of the longitudinal profile of these which remarkably recalls the reality; the representative contours of the glacier when increasing and when decreasing here present a striking resemblance to the profiles observed. Calculation has been applied, even, with encouraging results, to the case of the glacier of three dimensions. These theoretic tests have, however, been purely kinematic thus far, and teach us nothing as to the forces at work; upon this point, indeed, the theory of the glacial flow itself is still to be established.

[9]E. Brückner: Variations of Climate. Vienna, 1890 (Hölzel).

[10]Loc. cit.

[11]H. Hess: Die Gletscher (Glaciers). Brunswick, 1904.

[12]The mensurations of the glacier of the Rhône had already revealed incessant though modest variations of the speed of flow in the transverse sections studied.

[13]Cf. Series of Reports on the variations of glaciers of the Swiss Alps since 1903. *Annuaire de C. A. S.* Stämpfli; Berne.

[14]H. Hess: On the Plasticity of Ice. *Ann. d. Physik*, 4th series, vol. XXXVI, 1911.

[15]R. S. Tar & L. Martin: The Earthquakes at Yakutal Bay, Alaska, in Sept., 1899. Gov. Pr. Off., Wash., 1912.

[16]L. de March: The Periodic Variations of Glaciers. *Rendiconti dei 2. Ist. Lomb. di sc. clett.*, series II, vol. XXVIII, 1895.

[17]Finsterwalder: The Theory of Glacier Variations. *Am. de Glaciologie*, vol. II, fascicle 2, 1907.

Photo by The Gilliams Service

A portion of an 8,000-acre potato plantation in Florida

Photo by The Gilliams Service

Planting potatoes on land that was a wild swamp a year before

Spuds by The Million

What Florida Farmers Are Doing To Prevent A Potato Famine

EVERY one remembers the potato famine we had last spring, how the indispensable "spuds" were at times almost impossible to secure and so high priced that they were almost worth their weight in gold.

Well, here is some good news. If the farmers of Florida can prevent it this state of affairs will not occur again, as ever since last spring, in response to the call of Mr. Hoover and Uncle Sam's Food Administration, they have been turning swamp lands into scientifically cultivated fields for the growing of plenty of potatoes.

In the famous Hastings district, where the gross receipts from potatoes last year were $7,000,000, the cultivated area has been increased 8,000 acres since the 1917 planting season.

The case of an owner of eighty acres of wild swamp land, near Elkton, is typical. After the Government's call for a larger production of food he began an attack on the swamp with a force of negro laborers. Trees were felled—and they averaged 500 to the acre; drainage ditches were dug and the ground put under cultivation in a marvelously short time. Now there is a clearing of fifty acres planted to potatoes.

The Florida potato growers market their product through a cooperative association. The association is thoroughly up to date and operates potato barrel factories and a chain of general merchandise stores through the district.

Florida potatoes are shipped in a standardized barrel which holds eleven pecks or 165 pounds. A factory at Elkton has a capacity of 6,000 barrels a week. The staves are made from cypress and pine wood, the hoops of elm and the heads of gum and pine. Timber is fortunately plentiful in the district and barrels are turned out at a low cost.

The new potatoes are graded and packed in barrels, ready for shipping, in the fields. The prices last year were $8 to $12 a barrel. At such prices it is not remarkable that a number of growers are on the way to becoming wealthy in a few years. One prominent Florida potato farmer is said to have made last year a profit of $70,000 and another a profit of $25,000.

While potatoes are grown as a truck crop in various parts of Florida they are strictly a farm crop in the Hastings district. In this section the entire acreage of the farms is planted to potatoes and they receive the undivided attention of the farmers. While Irish potatoes have been grown in Florida for forty years, it was not until the war that they have been considered an important crop except in very limited areas, and then only on soils best suited to this purpose.

In Florida Irish potatoes are planted principally in flat woods soils, much of which is underlaid with hardpan at varying depths. Where the hardpan is close to the surface it has to be broken by subsoiling or by the use of dynamite. When the hardpan is three and one-half to five feet below the surface it becomes an advantage by preventing irrigation water from draining away too quickly.

Much of the soil has little humus, strange as it may seem in a land of much vegetation, but by rotation of crops large amounts of vegetable matter may be turned under each year until the result is a first-class potato growing field. Flat lands have to be well drained. Hammock lands, when well drained, are suited to Irish potatoes because of the amount of humus contained in this soil and its ability to hold moisture. High sandy lands are less suited to potatoes than flatwoods or hammock, because of the lack of moisture during the growing season.

The favorite variety in the Hastings district is the Spaulding Rose 4, a smooth potato which grows rapidly, matures early and is a good shipper. Varieties preferred in other districts are the Irish Cobbler and Bliss Triumph, the latter a favorite for fall planting.

Most of the potatoes in Florida are planted in winter and are sold in the Northern markets early in the spring in advance of the product from other States. From Tampa southward the planting is done between December 15th and January 15th; between Gainesville and Tampa, from January 1st to February 20th; and in sections north and west of Gainesville, February 1st to March 10th. The growers around Hastings begin planting the middle of January.

The shipping season begins in April and extends into May, a period when there is a good demand for new potatoes in the Northern markets. The potatoes are shipped by freight in carload lots, as the cost of shipping by express is prohibitive except in the case of very early shipments or when prices are exceptionally high. The yield is as high as seventy-five barrels per acre with forty at the average.

The Hastings growers market their potatoes before they become thoroughly ripe. When the crop has grown to a marketable size, and the skin slips to the pressure of the thumb, the potatoes are dug—except in cases where the tubers are to be used for seed, and then they are permitted to remain in the ground until the tops are almost mature.

When there are no set-backs the potatoes in the Hastings district are ready to harvest in eighty to ninety days after planting. The tops usually die in about 120 days after planting, when the growth of the potato stops.

"Potato kings" of Hastings have adopted a scientific method of crop rotation which produces good results. Potatoes, corn and cowpeas form the cycle for each year. It is the common practice to plant corn close to the potato rows so that when the tubers are dug with hand tools the young corn is cultivated at the same time. When the corn is almost mature, cowpeas are planted between the rows, giving a third crop on the land. Where cowpeas are not grown the land usually is permitted to be overgrown with native grasses which are cut and used for hay or turned under to form humus.

The housewives of Florida are showing loyalty to both state and nation by using potatoes liberally in the daily menu. The wife of a prominent grower of Hastings pointed out how potatoes could be used in bread and cake, as a main dish, boiled, baked, mashed, fried, scalloped with cheese and with cornmeal muffins and sausage.

Potato growing is not, however, a sure "get rich quick" business, for, like all other crops there are good and bad years to be expected. In a recent discussion of the subject an authority on the subject made the following very pertinent statements, which it would be well if everyone considering going into potato growing would consider:

"Going back over the records of our potato crops for as many years as you please, you will find that a large crop is almost invariably followed by a small crop, and that by a large crop again. This means that our potato-growing industry is unstable—speculative—governed by false standards of year-to-year prices and profits, which penalize the producer, enforce irregular profit-taking upon the distributor, and prevent the consumer from getting this staple food at just prices. After a year of potato scarcity, like that of 1916-17, high prices stimulate a large increase in acreage. Thousands of farmers plant potatoes, fascinated by the money that they were bringing during the planting season. It is not, however, over-production of what the country might consume if the industry were stabilized, and the use of potatoes systematically increased, with corresponding improvements in the distributing organization.

Because our per capita consumption is low and our distribution disorderly, such increase of the crop invariably leads growers to cut down their acreage the following spring, and there is another period of shortage and unreasonable prices.

With the large crop in sight last fall, the swing of the pendulum became a serious danger. If growers could not make a reasonable profit upon potatoes, there would be a shrinkage in production.

The right way to raise potatoes, the method followed by every farmer who makes money upon them, is to plant about the same acreage every year, regardless of spring prices, get costs on an efficient basis by skill and good soil and machinery, and count upon the certain profit that governs the five-year average. If there were not this certain profit in the five-year average, taking the losses with the gains, it is self-evident that potatoes could not be raised at all."

The Dakin or Carrel-Dakin Solution

THE original Dakin solution consisted of hypochlorite in conjunction with boric acid. This preparation, however, was found to have irritating properties when applied to wounds and has been modified by Daufresne by the substitution of sodium bicarbonate for the boric acid. The solution is made from bleaching powder, according to the following recipe, which is calculated on the basis of 30 per cent of available chlorine in the bleaching powder: 154 grms. of bleaching powder is placed in a 12-litre bottle with 5 litres of water, the mixture is shaken vigorously for a few minutes and allowed to stand, with intermittent shaking, for 12 hours. Seventy-seven grms. of dry sodium carbonate and 64 grms. of sodium bicarbonate are dissolved in 5 litres of water and added to the mixture in the bottle. After the calcium carbonate has settled, the solution is siphoned off through a filter and is ready for use. The liquid must contain between 0.45 and 0.50 per cent of sodium hypochlorite and must give no pink coloration when 0.2 grm. of phenolphthalein is sprinkled over its surface. If the available chlorine in the bleaching powder be different from 30 per cent, the above quantities of ingredients must be corrected accordingly.—I. GRIFFITH in *Am. Journ. Pharm.*

Spitzbergen and Its Resources

The interest that has been taken in Spitzbergen and its possibilities of recent years has given rise to many apparently contradictory statements, including that of a Russian annexation, and Swedish, Norwegian, and German control. The reason is that paragraphs dealing with the country are generally inspired, and, while giving details—often exaggerated—of the work being done by the interest contributing the matter, ignore the progress that is being made by other nationalities. Spitzbergen is, in fact, a "No Man's Land." It belongs to no nation, and is under no flag, or rather under a multiplicity of flags, according to the nationality of those developing parts of the land. It is true that the country was formally claimed on behalf of James I., in 1614, by the Muscovy Company, acting under an Order in Council, authorizing them to "uphold the King's Right to Spitzbergen"; the "Right," however, has apparently lapsed, and the country is now generally recognized as one of the few places on the earth unclaimed by any nation. It is, however, one that is likely, in the near future, to occupy a prominent position in North European affairs.

Prominence has been given during the past two years to the work being done by Norwegian companies, one of which, A/s det Store Norske Spitzbergen Kulcompani, of Christiania, recently purchased the holdings of the Arctic Coal Company—an American concern—and added these to other claims, with a view to economic developments. The other, A/s de Norske Spitzbergen Kulfelter, of Bergen, secured the claims of the Spitzbergen Coal and Trading Company, of Sheffield. The first-named is working on an extensive scale, but experienced a considerable amount of labor trouble during the past summer; the second has, as yet, made little progress. (The Arctic Coal Company, in their best year, secured an output of coal exceeding 60,000 tons.) The Norwegian workings (with the exception of that of one concern, working on British-owned territory) are all situate on the south side of Ice Fjord. Coal extraction is also proceeding on the west side of Green Harbor, on account, it is understood, of a Russian syndicate. This concern was seriously handicapped last winter and spring by the loss of their supply ship, which was wrecked at the entrance of Green Harbor in the autumn of 1916; it has now recovered, and is making good progress.

The latest information published respecting Spitzbergen refers to work being carried out and contemplated by a Swedish company—Aktie. Svenska Kulfelter Spetsbergen, of Stockholm—formed last year to take over the holdings of Aktiebolaget Isfjorden-Belsund, in Braganza Bay and elsewhere. A well-equipped expedition left Tromso in July last, and the venture appears to be one of high promise. The information contained in the article on page 493, *ante*, in our issue of November 9, may be taken as correct, so far as the extent of the deposits alluded to are concerned, and may be regarded generally as typical of the wealth of the Spitzbergen coal fields. The territory referred to as Bunzow Land (otherwise known as the Sassen Bay Peninsula), and amounting to over one-third of the total claims, and five-sixths of the potential output of the Swedish company, is included in the claims of the Scottish Spitzbergen Syndicate, Ltd., of Edinburgh, and, if their claim to this land be substantiated, should be classed as British-owned territory.

The approximate areas of claims made by respective nationals in Spitzbergen are as follows:

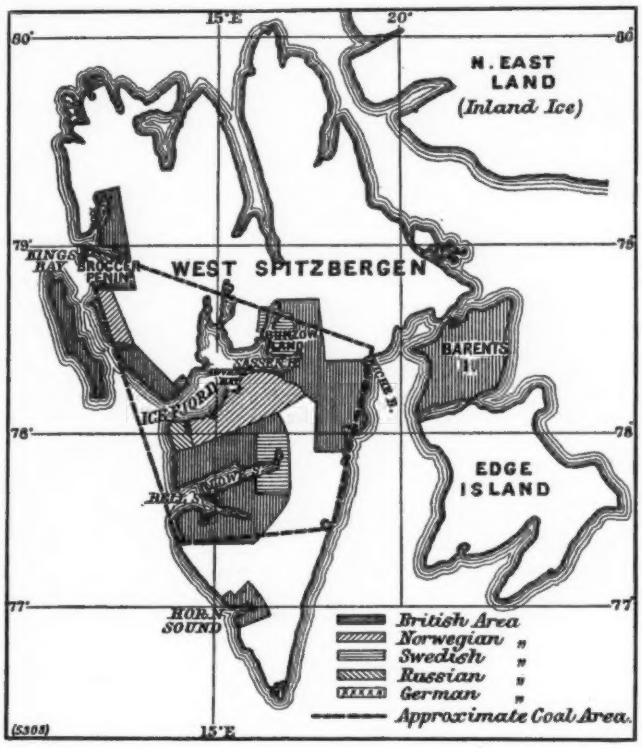
	Square Miles.
*British	3,574
Norwegian	770
†Swedish	448
Russian	80
German	23

Of these, the greater part of the British-owned areas are coal-bearing; in fact, with the exception of the German claim, the buildings on which were erected mainly for meteorological purposes, the remainder are being worked for coal alone.

The coal areas of Spitzbergen may be stated to extend generally from the Brogger Peninsula to Wiche Bay (see map), thence south to Whales Bay, west to Dunder Bay, and north to the starting-point. There are few mountain ranges within the lines stated where coal does not outcrop. The deposits are mainly situate from 250 feet to 600 feet above sea-level, so no sinking of shafts is necessary and no firedamp is encountered. Working can proceed all the year round. The coal comprises anthracitic, bituminous and cannel varieties, and is specially suited both for steam-raising purposes, and for burning in closed stoves—the ordinary method of fuel consumption for domestic purposes throughout Scandinavia and North Russia.

*Not including Bunzow Land.
†Including Bunzow Land.

The quality of the coal in Braganza Bay (the only place where the Swedish company has carried out extensive working) is no better than that of Bell Sound—owned by the Northern Exploration Company, Ltd., of London—and the latter is of far greater extent. It is slightly better than Advent Bay coal, now being developed by the Norwegian companies referred to, but is at least equalled by that in course of working in Green Harbor by Messrs. Lewin on Russian account.



Those with a knowledge of the deposits have not the slightest doubt that Spitzbergen will ultimately be able to supply all the coal required for Scandinavia and Northern Russia. In this respect, the fields which are British-owned, mainly lying north and south of Bell Sound and Lowe Sound, are nearer than any others, are more accessible, and are of far greater extent; they can, provided facilities are afforded during the war, obtain and hold a dominant position.

In addition to the coal deposits, the British-owned territories are highly mineralized, containing iron ore (hematite and magnetite), marble, copper ore, iron and copper pyrites, molybdenum, galena, zinc-blende, and other minerals. Arrangements were practically completed for the extensive development of several of the properties at the time of the outbreak of the war, but were necessarily held in abeyance. Now that other nations are making headway, and considering that coal-control (specially in conjunction with iron deposits) is of great value to the possessing nation, it is a matter for serious consideration whether the time is not opportune for special facilities to be afforded, in order to maintain British control over coal and other mineral deposits that are British-owned.

The projected railway mentioned in our previous issue must cross British-owned territory. The regulations prevailing make it extremely difficult for a British expedition to be equipped, during the war, without Government sanction and support; meanwhile, neutrals, not always our best friends, are taking advantage of the opportunities to establish themselves and gain control of available markets. It is necessary for British owners of Spitzbergen territory to be in a position, not merely formally to protest against, but to prevent trespassing on the part of other nationalities.

The control of Spitzbergen will, in the near future, be a political question of first importance, and, under the circumstances, it is advisable that every possible facility should be afforded for British concerns, recognized by the Government as the owners of the greater portion of the claimed land, to assume and maintain during the war the dominant position to which they are entitled.—*Engineering.*

The Aurora Borealis

The corpuscular theory of the aurora first advanced by Goldstein and subsequently developed by Paulsen and Birkeland, supposes that the sun is continually emitting into space charged particles, somewhat of the nature of cathode rays. Such of these as enter the magnetic field of the earth are converged by the action of the latter towards the earth and, entering the upper layers of the atmosphere either directly, or indirectly through the production of secondary cathode rays, produce the luminescence observed as the aurora. The theory has the observational support that the curve showing the frequency of auroral displays runs parallel to that representing the solar activity as evidenced by the sun-spots and prominences. The theory has been investigated theoretically by Carl Störmer, and a summary of the results so far obtained is given by him in *Terrestrial Magnetism*, 22, 23 and 97, 1917.

The problem is a difficult one to attack mathematically, and, for simplicity, the assumptions were made that the earth is a uniformly magnetized sphere, that no force other than the earth's magnetic force acts on the particles, and that their velocity is much greater than those of the earth and sun, so that the relative motion of the latter can be neglected. The investigation has involved the tracing, by numerical and graphical methods, of an immense number of different orbits of particles; it has been continued since 1903, and has included two expeditions to Bossekop in 1910 and 1913, for auroral observations, determination of heights of auroral curtains, etc.

The theory, combined with the fact that the earth's magnetic axis does not coincide with its axis of rotation, has been found adequate to explain the following auroral phenomena: There are southern and northern limits for the aurora borealis and aurora australis respectively, beyond which aurorae seldom or never occur; the large majority of auroral displays occur within two well-defined belts; they are of a sudden and variable character; they show a tendency to recur about the same time on two successive days and also after about twenty-seven days, the period of the sun's rotation; aurorae occur at the greatest distance from the earth's magnetic axis at the time of intenes magnetic storms. The existence of several auroral curtains at the same time can be attributed to the charged particles possessing several different velocities.

The theory, therefore, explains satisfactorily most of the phenomena observed. There is one outstanding difficulty—the situation of the belts of maximum auroral frequency. These are about 23 degrees from the magnetic axis. The theory gives only 6 degrees for β-rays of radium and 18 degrees for α-rays, so that it would appear that negatively charged particles cannot account for the aurora. It is possible that it is due entirely to the positively charged α-particles. Carl Störmer suggests alternatively that since theory indicates that a large number of particles bend round the earth on the afternoon and night side, the belt so formed may be of sufficient intensity to draw the position of maximum frequency down to that observed: investigation of this point shows that, without any great impossibility, this might happen even for negatively charged particles, and that the belt required for this purpose will not exert an appreciable magnetic force on the earth's surface. Further investigation may be expected to throw more light on this point. —H. Spencer Jones, M.A., in *Science Progress.*

Search For Two Unknown Metals

In the periodic classification of Mendeléeff there are vacancies for two elements with atomic weights about 99 and 187, which the author supposed might accompany unsuspected, molybdenum (96) and tungsten (184) in minerals. Slight differences in chemical behavior were found in specimens of tungstic acid prepared from different sources, and a complexity of the element tungsten was inferred. The abnormal specimens showed spectra identical with normal tungsten compounds. Similar results were found with molybdenum compounds, so that the spectroscopic evidence negatived the idea of complexity of tungsten and molybdenum. The author suggests the existence of isotopic forms of these elements after the analogy of lead.—Note in *Jour. Soc. Chem. Ind.* on an article by M. Gerber in *Monit Scient.*

The Problem of the Method of Evolution—II*

Observed Changes in Hereditary Characters in Relation to Evolution

By H. S. Jennings, Johns Hopkins University

[Concluded From Scientific American Supplement, No. 2203, Page 179, March 23, 1918]

Now, doubtless, there is a further diversity in the mental processes of the two sets of men, in that the mutationist thinks of all these numerous grades as after all essentially discontinuous, as a series of steps so minute that the difference between one and the next one is not detectible. His opponent, on the other hand, perhaps thinks of the series as actually continuous. But the difference is not a pragmatical one; when steps become so minute as to be beyond detection, the question whether they exist becomes metaphysical.

To put the case in brief, if the mutationists are to show that the existence of multiple modifying factors has any bearing on the general question of the effectiveness of selection, they must show that such factors are not themselves minute changes in the hereditary constitution. Not only have they made no attempt to do this, but in the only well-examined cases they state squarely that such factors are indeed alterations in the hereditary constitution.

For the inheritance of such factors as Mendelian units, of course absolutely nothing is required save that the location of the change is in a chromosome. No particular degree of magnitude; no unity of any other kind is required.

But there remains one point brought out by the mutationists which is of great importance to the student of the method of evolution. While they must admit, by their own account, that all these grades occur, so that a practically if not actually continuous series can be formed, they of course point out that the changes do not occur in a continuous series. In the eye of Drosophila variation may occur from red to white directly, without any transitional stages; or from any grade to any other; the continuous scale is obtained only by arranging the steps in order. Therefore, it is maintained, evolution may have occurred by such large steps, not by continuous gradations.[9] This is of course a matter deserving of serious consideration. But certain other points must be considered also. First, the very facts known for Drosophila show that there is nothing to prevent a passage from one extreme to the other by minute changes, just as is held to occur by the paleontologists and selectionists, although change by large steps occurs also. Secondly, in such cases as the eye color of Drosophila we are dealing with characters that are already highly developed. We know for example, that this particular character is formed by the cooperation of many separate parts of diverse chromosomes; it is a highly complex product of evolution. Now, we find that one or another of these parts may suddenly cease to perform its function, so that the red color is not completely formed; there is a sudden change in it; or it may disappear entirely. But is this after all strong evidence that in the original production of this complex character with its numerous underlying functional parts, there was the same change by sudden large steps? Indeed, is it not rather true that such destructive changes in a fully formed character could not be expected to throw light on how that character was built up?

I am not unmindful of the fact that there are a few—but only a very few—cases in which there is indication of a positive addition by a definite step, as when the eosin color is produced in white-eyed stock. But here again the underlying apparatus has before had the power to produce eosin and other colors. The white color was due to the temporary suspension of function in parts of the chromosomal apparatus, and it may be doubted whether the restoration of this function throws light on the way the apparatus was first developed.

To sum up, it appears to me that the work on Drosophila is supplying a complete foundation for evolution through selection of minute gradations. The so-called "multiple allelomorphs" show that a single unit factor may thus exist in a great number of grades; the "multiple modifying factors" show that a visible character may be modified in the finest gradations by alterations in diverse parts of the germinal apparatus. The objections raised by the mutationists to gradual change through selection are breaking down as a result of the thoroughness of the mutationists' own studies. We have already gotten completely rid of the notion that the germinal changes consist only in the dropping out of complete units, or that they are bound to occur in large steps. If the recent rate of progress is maintained, when such an organism as Drosophila has been studied for fifty years, instead of eight or nine, there will be no conceivable gradation of any character that will not have been detected. The only outstanding difficulty is the fact that large changes occur as well as small ones; this seems perhaps due to the fact that we are witnessing the disintegration of highly developed apparatus in place of its building up.

In all this, except the last point, the work on Drosophila is in agreement with my own observation of gradual variation in Difflugia; with Castle's similar results on the rat; and with the conclusions of paleontologists as to the gradual development of the characteristics of organisms in past ages.

But there is one point in the paleontological conclusions, as set forth in the recent papers by Osborn, which is not in agreement with the experimental and observational results on existing organisms; this I wish to notice briefly. Osborn sets forth that in following given stocks from earlier to later ages, characters arise from minutest beginnings, and pass by continuous gradations to the highly developed condition. This seems in agreement with experimental results, as I have tried here to set them forth. Further, according to Osborn, these developing characters do not show random variations in all directions, but follow a definite course, which might seem to have been in some way predetermined. And this is emphasized by the fact that the same sorts of characters (horns, for example) may arise independently, at different ages, in diverse branches of the same stock, and each follow in later ages the same definite course of development.

It would appear therefore from this that there must be some directing tendency, some inner necessity which drives a developing organ to follow a definite course. Evolution is characterized by Orthogenesis, as this phenomenon has sometimes been called.

Now it appears to me that we do not observe this in the present day experimental work; by selection we can move in more than one direction. I do not mean that the possible variations are not limited by the constitution of the varying organism; they certainly are. But there is no indication, so far as I can see, that the variations push in one determinate direction only.

Now, examining the paleontological summaries further as regards this (I refer to Osborn's papers), we find certain points that appear to modify seriously, if they do not quite nullify, this conclusion that variations follow a determinate course.

First, we do find that diverse courses are followed by given characters, in diverse branches of a given group; this is particularly true of the characters of shape and proportion, which Osborn calls allometrons. I take it from the descriptions that this is likewise true at times for structural and numerical characters.

A second point which Osborn sets forth is deserving of particular attention. He states, in agreement with Waagen, that in any given geologic stratum, we do find, in addition to characteristics that are in the line of determinate descent, other variations from this line, which are of the sort that constitute what we call at the present time varieties; things that are like the diverse races of Difflugia in my own work. But, say Osborn and Waagen, there is a great difference in principle between these and the others, for those which are in the determinate line of progress persist into the next geologic stratum, while the mere varieties do not. The persistent changes were called by Waagen, mutations (in a sense somewhat diverse from that in which the word is used by de Vries).

Osborn expresses the opinion that these "varieties" may be merely non-heritable modifications.[10] But in our present geologic period we find just such diverging forms, in great number, and we find that their peculiarities *are* heritable; this I emphasized in the introductory part of the present discussion. There is then no reason for supposing that these variations were not heritable in earlier geologic periods; there must have been many races heritably diverse, just as there are now; and these are what Waagen called varieties.

Now since this is so, the only difference between Waagen's mutations and his varieties, is that, on looking backward at them, we find that the former persisted and the latter did not. But this tells us nothing whatever about why the latter did not. It is perfectly possible, so far as these facts go, that it was a matter of selection by external conditions; many diverse stocks were present, on an equal footing; some were destroyed, others were not.

What ground then is there for saying that the development of given characters followed a definite course, as if predetermined? The conditions described are exactly what we should require to find if in past ages there were many varied stocks, some of which were preserved by the action of natural selection. Looking back over the series from a later age, we are bound of course to find it a continuous development. If the same characteristics were favorable in successive ages—and there is no reason why they should not be so—then the same sorts of variations would be preserved in those successive ages; a line of development once begun would be continued. And if the same sort of characters are favorable ones in different branches of a family, then similar characters may well arise and follow a similar course of development, in the diverse branches, as Osborn states they do. But at the same time many other heritable variations arise, that are not in the line of progress, and hence are not preserved through selection; these are precisely the "varieties" described by the paleontologists; the diverse races that I have described in Difflugia and Paramecium, and that are found to exist in all organisms. The conditions described by the paleontologists support strongly the theory of evolution by gradual change, but I cannot see that they tend to establish the view that variations show a tendency to follow a definite course, as if predetermined. The paleontologists appear rather to report precisely the conditions which we are bound to find if evolution occurs through the guidance of natural selection operating on a great number of diverse variations, the typical Darwinian scheme.

There is one other point which I wish I had time to take up, but I have not. I will merely attempt to state in a few words my impression of it. This is the point made by Bateson (1914) in his Presidential Address before the British Association, and farther developed by Davenport (1916) in a recent paper: the proposition, namely, that since practically all observed variations are cases of loss and disintegration, we are driven to suppose that evolution has occurred by loss and disintegration. Davenport combines this idea with the theory that these disintegrating variations follow a definite course, predetermined in large measure by the constitution of the disintegrating material.

There are two points worth consideration in dealing with this theory. The first is one of fact; although it is true that many of the so-called mutations appear to be cases of loss and disintegration, yet there is no indication that this is the case in such effects of selection as have been described by Castle and myself; variations are not limited to any particular direction. Secondly, it appears to me that this conclusion—that because the variations we see are cases of loss and disintegration, therefore evolution must have occurred by loss and disintegration—it appears to me, I say, that this conclusion involves an error in logic, which makes it unworthy of serious consideration. The syllogism which it involves seems something as follows:

1. *Major premise.* Evolution has occurred by progress from the visibly less differentiated in structure to the visibly more differentiated in structure.

2. *Minor premise.* By observation we detect only the visibly less differentiated arising from the visibly more differentiated; we see only a process of decreasing the visible differentiation.

3. *Conclusion.* The visibly more differentiated must have arisen from the visibly less differentiated, by decrease in the visible differentiation of the latter.

The conclusion is absurd; it cannot be drawn save

*A lecture delivered before the Washington Academy of Sciences and reproduced from the *Journal of the Academy*.

[9]See particularly the discussion of this point in Morgan, 1916, p. 7-27. (See Bibliography.)

[10]Osborn, 1915, p. 225. (See Bibliography.)

for the fact that while in the two premises we are talking of *visible* differentiation and disintegration, in the conclusion the ground is shifted to mean something entirely different—a sort of inner, invisible, purely theoretical kind of differentiation and simplicity and disintegration. By putting in the word *visible* all the way through, the absurdity is brought to light. All that we can legitimately conclude from the two premises is that we have not seen the process of evolution occurring. If we have seen nothing but loss and disintegration, this is indeed the conclusion that we must draw. But I believe that we cannot assert that this is all that we have seen.

To summarize then what I have obtained from experimental work combined with a survey of the work of others, the impression left is as follows:

1. Experimental and observational study reveals that organisms are composed of great numbers of diverse stocks differing heritably by minute degrees.

2. Sufficiently thorough study shows that minute heritable variations—so minute as to represent practically continuous gradations—occur in many organisms; some reproducing from a single parent, others by biparental reproduction.

3. The same thing is reported from paleontological studies.

4. On careful examination we find even that the same thing is revealed by such mutationist work as that on Drosophila; single characters exist in so many grades due to minute alterations in the hereditary constitution as to form a practically continuous series.

5. It is *not* established that heritable changes must be sudden large steps; while these may occur, minute heritable changes are more frequent.

6. It is *not* established that heritable variations follow a definite course as if predetermined; they occur in many directions.

7. It is not established that all heritable changes are by disintegration; although many such do occur, they cannot be considered steps in progressive evolution from the visibly less complex to the visibly more complex.

Evolution according to the typical Darwinian scheme, through the occurrence of many small variations and their guidance by natural selection, is perfectly consistent with what experimental and paleontological studies show us; to me it appears more consistent with the data than does any other theory.

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Correspondence

[The editors are not responsible for statements made in the correspondence column. Annonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Una-Flow Steam Engines

Editor SCIENTIFIC AMERICAN SUPPLEMENT:

In your SUPPLEMENT of January 19th, 1918, you published an article by H. W. Morley of England, relative to Una-Flow steam-engines.

Mr. Morley's experience was probably with engines in England and on the continent of Europe and it may be interesting to add a statement of the experience with such engines in the United States.

The failures which Mr. Morley mentioned as being due to the use of engines for purposes for which they were unsuited and in many cases to bad workmanship and improper design have occurred in this country also, but in most cases these failures were due to the latter cause, which resulted in seizing of pistons in cylinders a d the consequent cracking of the cylinders around the exhaust ports. This was due not so much to the type of engine as to the inexperience and lack of knowledge in design and construction. As a matter of fact, with respect to the limits of accuracy allowable in the machining of the pistons and cylinders on a commercial basis the difficulties mentioned in Mr. Morley's article have been entirely practical when proper knowledge and experience has been applied. No trouble whatever along this line has been experienced in this country when the benefit of knowledge and experience gained in the European designs have been utilized.

Mr. Morley may be right in his idea of the questionable advantage of the una-flow steam-engine when exhausting to atmosphere, but his remarks apply only when *low steam pressures* are used. As the steam pressure is increased and the clearance volume (not as Mr. Morley suggests *increased*) reduced, as the higher compression requires, the advantage of the una-flow over the counter-flow engine when operating with atmospheric exhaust greatly improves.

If the Rankine cycle, in which steam is admitted and then expanded adiabatically (that is to say without loss of heat in the engine itself) be taken as an ideal with which the actual cylinder performance as measured in steam consumption in pounds per I. H. P. hour may be compared, it will be found that the counter-flow steam-engine and una-flow steam-engines working on low pressures have about the same cylinder efficiency.

As the pressure range is increased the cylinder efficiency of the counter-flow engine falls off due to increased initial condensation; while that of the una-flow engine improves owing to decreased clearance volume, and its gain in economy is even better than that of the ideal cycle with increase of pressure.

A lack of sufficient experience makes it hard to draw the line at which the una-flow engine gains a marked advantage, but it has been conclusively shown by several hundred engines operating in this country that there is advantage in the una-flow system of steam pressures of 125 pounds and upwards when used *non-condensing*. As the tendency in this country is largely non-condensing and to the use of higher pressures, the una-flow engine is being more and more generally adopted for this kind of work.

Condensing engines obtain this advantage of una-flow over counter-flow type at lower boiler pressures, but the advantage may be said to increase in both cases when the range between initial and exhaust pressures are considered. Mr. Morley's statement, that altho the una-flow engine may be worked at high pressures, it then requires an increased clearance volume, or that it has yet to prove that economic results better than those of an engine of the ordinary type, does not conform with actual results obtained in this country.

The questionable advantage of the addition of exhaust valves to the una-flow engine, is agreeable to many—in fact most of the successful engines in this country are built without them.

High pressure una-flow engines have been built for automobiles, and with 450 pounds pressure and moderate superheat, remarkable performance has been shown. Larger engines are being built for tractor and marine work and it will not be long before additional proof, which Mr. Morley suggests is necessary will become available in actual performance on high steam pressure.

L. L. SCOTT, M.E.

Standard Engineering Symbols

THE Committee on Technical Nomenclature of the Society for the Promotion of Engineering Education, consisting of John T. Faig, S. C. Earle, W. D. Ennis, F. N. Raymond and Charles Warren Hunt, has prepared the accompanying tentative list of symbols to be used in works on mechanics. This list was prepared through consultation, by means of correspondence, with a large number of professors, editors and engineers in the mechanical field.

A = area;
a = linear acceleration;
b = breadth;
C = constant;
c = distance of extreme fiber from neutral axis;
D = diameter;
d = depth;
E = Young's modulus of elasticity;
e = eccentricity of application of load
e_h = hydraulic efficiency;
e_m = mechanical efficiency;
e_v = volumetric efficiency;
F = force;
f = coefficient of friction;
g = acceleration due to gravity;
H = head;
H_p = horsepower;
h = height;
I = rectangular moment of inertia;
K = coefficient; constant;
k = radius of gyration;
L = length;
M = moment of force or sum of moments of forces;
m = mass;
N = revolutions per unit of time;
O = center of rotation;
P = concentrated load;
Q = quantity of liquid flowing, in pounds;
R = reaction;
R_h = hydraulic radius;
r = radius;
S_t = unit stress in tension;
S_c = unit stress in compression;
S_s = unit stress in shear;
s = distance passed over;
T = torque;
t = time;
V = volume;
v = linear velocity;
W = weight of a body, or total weight;
w = angular velocity;
y = deflection of beam;
Z = modulus of section.

—*Machinery.*

Protector Against Hail of Marcillac at Chenavari (Ardeche)

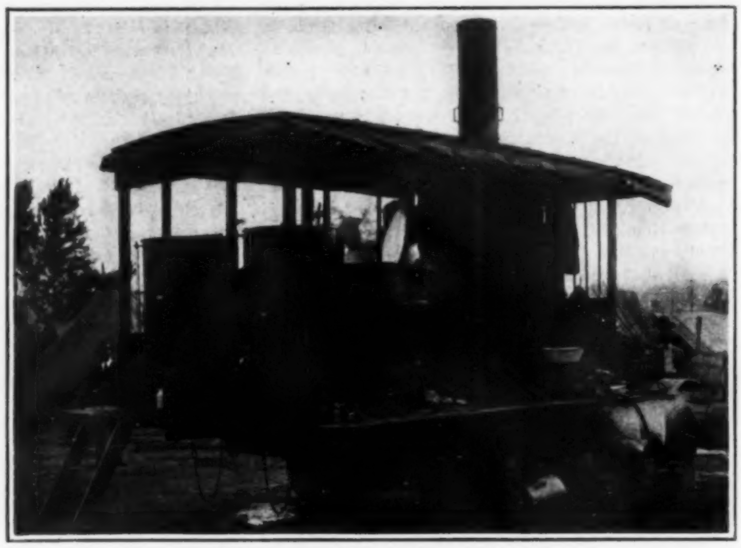
WOODEN poles are mounted upon an eminence of 508m. They carry flat iron aigrettes, earthed by iron bands, connected underground to iron perforated pipes filled with coke. The poles are arranged in polygon form, the diameter of a circle intersecting the position of the poles being about 90m. A pole is planted also at the center. The aigrettes are all joined together by barbed wire. There are nine poles. The area covered is about 6,000 sq. m. An additional earth is obtained at a small spring. Evidence is given of the diminution of hailstorms and of lightning discharges effected by this installation. But it is not stated over what area protection is afforded in this particular case.—From a note in *Science Abstracts* on an article in *Rev. Gen. d'El.*

Sulphur in Hypodermic Injections

THE increasing use of sulphur in hypodermic injections has led to a search for improved methods in this application. It is stated that Messrs. L. Bory and A. Jacquot made some successful researches in order to find whether it is possible to use as an injecting solution various liquids of a neutral and non-toxic nature which are capable of dissolving enough sulphur to be efficacious in the required applications. The best results among the bodies studied by them are shown by sesame and vaseline oils, camphor and eucalyptol. In practice they employ the following solution; pure precipitated sulphur 0.20 grammes, eucalyptol 20 grammes, sesame oil 80 grammes. This solution can be easily prepared on the water bath, and it allows of making injections of sulphur into the muscles in as large amounts as 10 milligrammes.

The Gilliams Service

French mobile kitchens just behind the trenches



An elaborate American automobile kitchen

Army Kitchens

although they cannot enjoy such a varied menu as is available at home, they require an abundance of the best quality to enable them to effectively keep up the strenuous work required of them. The kitchen is, therefore, a most important unit of an army, and considering the great numbers of men to be provided for it is a standing mystery to the layman how such immense quantities of food can be prepared regularly and promptly; for, no matter how active the fighting may be the work of providing meals for the troops must go on constantly, with as little intermission as possible.

To maintain the mobility of an army the kitchens are mounted on trucks of various kinds, some horse drawn, and others motor propelled, so that, no matter how sudden or how great a movement of troops may be made, the kitchens may keep pace, and be found within a convenient distance of the lines. The details of these movable food factories vary considerably, as may be inferred from the accompanying illustrations, but the great desideratum is an abundance of hot food quickly prepared.

In striking contrast with the army kitchens of the European troops are those of the native soldiers of India, of whom there are a great number serving with the British forces. Not only are they prohibited by their religious customs from eating certain kinds of food, but it must be prepared in a certain manner. Moreover, the touch of certain other people is regarded as contaminating; consequently they are provided with their own separate supplies, which they prepare according to their ancient customs. These peculiar customs have resulted in considerable difficulties in hospitals, for all of the intricate "caste" formalities must be strictly observed, even when only a single man is under treatment. This has resulted in the establishment of, sometimes, three separate kitchens in a single hospital treating as many men.

The Flora of the Somme Battlefield*

The ground over which the Battle of the Somme was fought in the late summer and autumn of 1916 rises gradually towards Bapaume, and at the same time is gently undulating, with some well-marked branching valleys initiating the drainage system of the area. Before the war the land was for the most part under cultivation, but on the highest levels there were large areas of woodland, such as High Wood and Delville Wood, now shattered and destroyed.

During last winter and spring all this country was a dreary waste of mud and water, the shell-holes being so well puddled that the water has remained in them, and even in the height of the summer there were innumerable ponds, more or less permanent, in every direction.[1]

The underlying rock is everywhere chalk with a covering of loam of varying thickness. As a result of the bombardment the old surface soil has been scattered and the chalk partially exposed. One effect of the shelling, however, has been to disintegrate the underlying chalk and produce a weathering effect which has been accentuated by the winter rains, snow and frost. A general mixing of chalk, subsoil and scattered top soil and also a rounding of the sharp edges have taken place, so that instead of the new surface soil being sterile, the shelling and weathering have "cultivated" the land. That this is so is proved by the appearance of the Somme battlefield during the past summer.

Looking over the devastated country from the Bapaume Road, one saw only a vast expanse of weeds of cultivation which so completely covered the ground and dominated the landscape that all appeared to be a level surface. In July poppies predominated, and the sheet of color, as far as the eye could see, was superb; a blaze of scarlet unbroken by tree or hedgerow. Here and there long stretches of chamomile (*Matricaria chamomilla*, L.) broke into the prevailing red and monopolized some acres, and large patches of yellow charlock were also conspicuous, but in the general effect no other plants were noticeable, though a closer inspection revealed the presence of most of the common weeds of cultivation, a list of which is given below.

Charlock not only occurred in broad patches, but was also fairly uniformly distributed, though masked by the taller poppies. Numerous small patches were, however, conspicuous, and these usually marked the more recently dug graves of men buried where they had fallen. No more moving sight can be imagined than this great expanse of open country gorgeous in its display of color, dotted over with the half-hidden white crosses of the dead.

In all the woods where the fighting was most severe not a tree is left alive, and the trunks which still stand are riddled with shrapnel and bullets and torn by fragments of shell, while here and there unexploded shells may still be seen embedded in the stems. Aveluy Wood, however, affords another example of the effort being made by Nature to beautify the general scene of desolation. Here some of the trees are still alive, though badly broken, but the ground beneath is covered with a dense growth of the rose-bay willow herb (*Epilobium angustifolium*) extending over several acres. Seen from across the valley, this great sheet of rosy-pink was a most striking object, and the shattered and broken trees rising out of it looked less forlorn than elsewhere.

The innumerable shell-hole ponds present many interesting features to the biologist. In July they were half full of water, and abounded in water beetles and other familiar pond creatures, with dragonflies flitting around. In nearly every shell-hole examined, just above the water-level, was a band of the annual rush (*Juncus bufonius*, var. *gracilis*), and this plant appeared to be confined to those zones where the ground was relatively moist, and to occur nowhere else. With the Juncus, and often growing out of the water, were stout plants of *Polygonum persicaria*, and water grasses, not in flower, were often seen spreading their leaves over the surface of the pools.

In the battlefield area not only were the common cornfield weeds to be seen, but here and there patches of oats and barley, and occasionally plants of wheat, sometimes apparently definitely sown, perhaps by the Germans, though more often the plants must have grown from self-sown seeds of crops that were on the land before the war. Here and there, too, could be seen opium poppies representing former cultivation and remnants of battered currant and other bushes which alone remained to show where once had been a cottage garden. Both weeds and corn afford good evidence that the soil has not been rendered sterile by the heavy shelling, but how and when the land can be brought into a fit state for cultivation are questions not easily answered.

On the banks and sides of the roads traces of the old permanent flora still remain, and perennial plants, such as *Scabiosa arvensis*, *Eryngium campestre*, *Galium verum*, chicory, *Centaurea scabiosa*, *Cnicus acaulis*, and other characteristic chalk plants were occasionally seen.

The clothing of this large tract of country with such a mass of vegetation composed almost entirely of common annual cornfield weeds is remarkable when one remembers that it has been the seat of encampments, and for the most part out of cultivation since the autumn of 1914. It is well-nigh impossible that such masses of seed can have been carried by wind or birds to cover these thousands of acres, and the plants must therefore have grown from seed lying dormant in the ground. No doubt in the ordinary operations of ploughing and tilling of the ground in years before the war much seed was buried which has been brought to the surface by the shelling of the ground and subsequent weathering. In this connection the presence of charlock on the more recently dug graves, where the chalk now forms the actual surface, is of interest, since it adds further proof of the longevity of this seed when well buried in the soil.

LIST OF PLANTS

Delphinium Ajacis, Reichb., larkspur; *Papaver Rhoeas*, L., poppy; *Fumaria officinalis*, L., fumitory; *Raphanus Raphanistrum*, L., white charlock; *Brassica sinapis*, Vis., yellow charlock; *Matricaria chamomilla*, L., chamomile; *Centaurea cyanus*, L., cornflower; *Cnicus arvensis*, Hoffm., thistle; *Sonchus arvensis*, L., corn sowthistle; *Sonchus oleraceus*, L., sowthistle; *Specularia speculum*, A. DC., looking-glass flower; *Anagallis arvensis*, L., scarlet pimpernel; *Myosotis arvensis*, Hoffm., forget-me-not; *Convolvulus arvensis*, L., small bindweed; *Solanum nigrum*, L., nightshade; *Plantago major*, L., etc., plantain; *Veronica hederaefolia*, L., etc., speedwell; *Galeopsis ladanum*, L., hemp-nettle; *Chenopodium album*, L., goosefoot; *Atriplex patula*, L., orache; *Polygonum aviculare*, L., knotgrass; *Polygonium persicaria*, L., persicaria; *Rumex obtusifolius*, L., dock; *Euphorbia helioscopia*, L., sun spurge; *Mercurialis annua*, L., dog's mercury; *Juncus bufonius*, L., var. *gracilis*, St. Amand rush. A few grasses and occasional plants or patches of oats, barley and wheat.

*Abridged from an article by Capt. A. W. Hill, Assistant Director, Royal Botanic Gardens, Kew, in the *Kew Bulletin of Miscellaneous Information*, Nos. 9 and 10, 1917. Reproduced from *Nature*.

[1]For a description of the battlefield shortly after the fighting Mr. John Masefield's recently published book, "The Old Front Line" (Wm. Heinemann), should be read.

Soldiers must eat the same as other people, and,

Use of Lime in Bread-Making

The acidity of flour and the bad odor and keeping qualities of bread are not caused by enzymes in the bran but are due to bacterial action, the growth of the bacteria being promoted by defective drying of the grain. The enzymes and bacteria are not affected by small quantities of acids or alkalis, and the use of lime-water in making the dough is useless, if not even injurious, when a poor yeast is employed. Bread made with the use of lime-water is less digestible than ordinary bread owing to the conversion of the acid phosphates into insoluble phosphates.—Note in *J. Soc. Chem. Ind.* on an article by J. Effront in *Monit. Scient.*

The Gilliams Service

The troops from India, fighting in France have their own ideas of food and how it should be prepared, so they build their kitchens to suit themselves

The Gilliams Service

The religion, and the "caste" system of the Indians, forbid them eating food, that has been touched by any "unclean" hands, so it is prepared entirely by their own people

Age-Societies of the Plains Indians*

By Robert H. Lowie

AGE-SOCIETIES occur, strictly speaking, among only five of the Plains tribes, the Hidatsa, Mandan, Blackfoot, Arapaho and Gros Ventre, and the system of the first-named may be taken as typical. Among the Hidatsa the entire male population was divided into about ten societies, each composed of men or boys of about the same age. An individual did not belong to a society automatically by virtue of his years, however; rather was he obliged to buy membership in company with his age-mates. Thus, young boys of, say, ten would not form any organization, but as they grew up would come to covet membership in the lowest grade, the Stone Hammer Society, then held by their immediate seniors. That is, they desired to possess the privilege of performing a certain dance, of wearing the distinctive regalia of the organization, and exercising whatever other prerogatives were bound up with the native notions concerning the Stone Hammers. In order to consummate their wishes, they dispatched gifts to the older boys, whom they humbly addressed as "fathers," and these attempted to fix as high a purchasing price as they were able to extort. For possibly ten or even twenty nights the members of the younger group were obliged to feast the sellers and give presents of blankets and horses, and when the older group had made the requisite paraphernalia and conveyed necessary instructions to the buyers, the purchase was considered complete. The younger boys then paraded about the village with their newly acquired badges and performed the newly learned dance, while the "fathers" merely acted as musicians—and thereafter had no more rights to Stone Hammer membership. It was now the turn of the older boys to purchase entrance into the next grade by going through essentially the same rigmarole, and so on throughout the entire scheme of organizations.

One problem in particular aroused the interest of students in connection with this institution. What is the relation of the age factor to purchase? Organizations founded purely on age would not involve any entrance fee; on the other hand, if the purchase were essential, why were fellow-members always of the same age? It would seem plausible that on that assumption a well-to-do youth might rapidly acquire one membership after another until he had attained to the highest rank. This puzzle becomes all the more pressing when we find that the organizations graded by age among the five peoples mentioned occur among other Plains tribes without any grading or age qualification, but that the purchase occurs only with the age factor, although it would seem that these two elements were mutually contradictory.

One of the first points that became clear as the investigation progressed was that any particular society was not essentially connected with a particular age even though all the members were age-mates. That is to say, it appeared that while, say, in 1840 all the individuals in the Dog Society were forty-five years old, in 1860 they may have averaged sixty in the same tribe, and perhaps only thirty elsewhere. The astonishing fact also came to light, that one and the same group might simultaneously hold several memberships. In 1910 an old Hidatsa informant still considered himself a member of a society he had joined at seven, of another he had entered at twenty, of a third he had joined at twenty-seven, and of a fourth he had purchased at about forty-five. Similar statements were obtained from other witnesses, and they were uniformly accompanied by the explanation that a man had a right to every society he had ever bought which for some reason he had never sold. This seemed to establish definitely the predominance of the purchase notion. If the societies had any direct relation with age, it was absurd to assume that a group or individual could be simultaneously connected with several groups.

Nevertheless this could not be the whole story, since the age of all the members of a society at a particular period was practically uniform in spite of the variations in age permissible for one and the same organization at different times. The whole matter is cleared up only when we understand the mode of purchase, which is collective rather than individual. A group of young boys playing together and forming approximately an age-group are constituted into a definite body by jointly passing through the initial social experience of buying the lowest grade. By simply continuing together at every successive purchase, they form a permanent union of age-mates, and since all groups follow the same course of action, the association of organizations with bodies of coevals is quite intelligible.

The Plains Indian age-societies are especially interesting because of their analogies to institutions of remote areas, which, however, merely serve to throw into relief the distinctive peculiarities of the American phenomena. Thus, in Melanesia all the men are ranged about a number of fireplaces in a clubhouse, each fire being associated with a distinct grade of the order. Each degree is purchasable and accordingly the series seems comparable to the Hidatsa scheme. Yet it differs fundamentally, because in Melanesia the buying is a purely individual affair, so that most men never advance beyond the middle ranks, while only the especially wealthy and fortunate reach the top. In other words, here there is grading with purchase but no suggestion of *age*-societies. On the other hand, the Masai of East Africa have age-companies formed during the tribal initiation ceremonies. The principle is really very similar to the Hidatsa one, for here too the organization of a permanent social unit results from a joint social experience. But the nature of that experience is very different from that of the Hidatsa, and more particularly, there is no trace of the element of purchase which figures so largely among the North American Indians. In short, there is merely analogy not homology and the Plains Indian age-societies remain an institution *sui generis*.

The data collected on the Plains Indian age-organizations have a direct bearing on certain sociological theories that have figured prominently in ethnological literature. The late Dr. Heinrich Schurtz, of Bremen, assumed that community of age was the earliest bond that united men into definite societies and that all other forms of organization, such as societies based on religious motives, came later in human evolution. At the same time he conceived the early division of male society to be according to three distinct groups, such as boys, married men and old men. This was a very plausible assumption since such a rough classification might be made even in primitive times, while a more minute division would seem improbable with people who do not reckon their ages by years. The Hidatsa phenomena show that refined classification is quite possible at a primitive level. All that is needed is that a group of boys should be consolidated by jointly acquiring a certain status and that this practice should become fixed for succeeding groups of boys. Then the total number of companies in a given tribe will simply depend on the number of groups which have passed through the initial experience. Among the Plains Indians the permanence of the bond is emphasized by the fact that the same group of individuals which purchased the Stone Hammer membership will later buy the Kit Fox, Dog and all other organizations. But this is not essential, since the Masai have permanent age classes with definite privileges but only a single social experience, the initiation ceremony, through which all tribesmen have to pass. The indispensable thing is thus merely that the first welding together should establish a permanent bond of union.

We can, therefore, understand how as many as ten or more age-groups could readily develop in a tribe without any conscious subdivision of the whole population. It is also plain that age plays an important part, since it is the bond that unites the boys before they collectively acquire the status of the lowest grade. Among the Plains Indians, the factor that unites individuals into a group is really age, as Dr. Schurtz contended, but the factor that determined that the group so constituted should become the possessor of certain ceremonial and social prerogatives, was purchase.

A very important problem is whether the age-grading is the earliest bond of organizations in human society. The Plains Indian phenomena definitely contravene this hypothesis. While it is true that some of the organizations seem to have originated among the tribes with graded schemes, other societies certainly developed elsewhere and were secondarily united with the age series. There can be no doubt that in some instances admission is based on purely social considerations regardless of year, while in others a certain form of religious experience shared by a group of men constitutes the sole bond of union. In short, age is certainly a real force in the evolution of tribal societies, but it is far from being the only socializing factor and there is no reason to think that it preceded all others, least of all, in North America, where organizations not based on age far outnumber those that are.

*From the *American Museum Journal*, issued by the American Museum of Natural History of New York.

A New Food Chart

UNDER the name of the "Inometer" Prof. T. Johnson, of the Royal College of Science for Ireland, has introduced a new form of food chart, constructed on the principle of the thermometer. The degrees on the scale represent large calories, and the principal points are placed at 4,000 calories, 3 500 calories, 3,000 calories, 2,500 calories, and 2,000 calories. These represent the food energy (expressed in calories) requisite for the performance of a day's work, ranging from heavy muscular work at 4,000 calories to sedentary work at 2,500 calories, the energy expenditure of a man resting in bed being placed at 2,000 calories. In addition, there are interpolated at various points on the scale the numbers of calories furnished by definite quantities of a variety of common foods.—*Nature.*

Antiseptics*

Work done for the British Medical Research Committee in the Pathological Department, Edinburgh University

By Theodore Rettie, D. SC.

In January, 1915, the National Insurance Medical Research Committee, at the request of the War Office, issued an appeal to the various medical schools to institute research on several problems which had been encountered in the medical service at the front. One of the most urgent requirements was a reliable antiseptic for the treatment of heavily infected wounds, with special attention to spore-bearing organisms. Professors Lorrain Smith and Ritchie at once organized several sets of workers to investigate the various problems, under their own direction. The work on antiseptics was carried out by Professors Dr. A. Murray Drennan, now Professor of Clinical Pathology in Otago; Dr. W. Campbell, now a Captain in the R. A. M. C., stationed at Alexandria, and myself.[1]

It may seem strange that over 40 years after the introduction of antiseptic surgery by Sir Joseph Lister no ideal antiseptic has been devised for such emergency treatment: the explanation, I think, is to be found in the tendency of modern surgery to leave as much to the recuperative power of the patient's own body as possible. In preparing for operation the surroundings of the patient are rendered as sterile as possible. Instruments, swabs, dressings, everything that will come in contact with him, are sterilized by heat. In fact, nothing that is not sterile is allowed to touch him. Under such conditions the only antiseptic necessary is some iodine solution to sterilize the patient's skin, and lysol or such preparation in which to place instruments after use. In accident cases where the wound is already infected, the injured tissues are carefully dissected out under chloroform and the wound cleansed with some strong antiseptic, most often with 5% aqueous carbolic acid, Lister's original antiseptic, or, by some of the ultra-aseptic surgeons, with large douches of sterile saline (0.85% salt solution—this is known as normal saline as its osmotic presure is equal to the pressure of the plasma of the body). Such procedure, though successful with a limited number of patients, obviously cannot be applied in a casualty dressing station; the wounds are always contaminated: they are deep, often ramifying, and may contain pieces of clothing or splinters, all presumably carrying infection. To meet such conditions powerful remedies are necessary, but they must be discriminatingly powerful; microbes which are vegetable cells must be killed, both vegetative forms and spores, which are much more resistant. At the same time the animal cells of the tissues must be damaged as little as possible by the antiseptic; free drainage for all discharges from the wound must also be maintained.

In opposition to the antiseptic method there is what has been called the physiological method of wound treatment, introduced by Sir Almroth Wright. The wound is treated with a hypertonic saline solution, i. e., a solution having an osmotic pressure higher than that of the plasma. As a result of this, fluid is rapidly poured out by the tissues, the idea being that the microbes are thus washed out of the wound and at the same time destroyed by the bactericidal properties of the lymph.

In support of this method the argument was advanced that any antiseptic damages the tissue to which it is applied to such an extent that the value of it as a destroyer of bacteria is lost, and the dead cells and coagulated albumin which the antiseptic leaves in the wound are a fertile source of further trouble. By hypertonic saline treatment this difficulty is avoided. With these two principles in mind, our object was to find an antiseptic agent thoroughly efficient as a killer of bacteria and spores, and at the same time harmless from the point of view of the wound tissues.

Our first step was to test the comparative efficiency of all the antiseptics in general use. It is obvious that it is impossible to make a definite statement as to the value of an antiseptic for wound treatment from its behavior under laboratory conditions. Most elaborate experimental methods have been devised in the endeavor to fix a standard by which antiseptics may be tested, but further research has shown that so many factors enter into the efficiency problem that test tube methods have come to be regarded more or less as a compromise. For instance, Chick and Martin[2] have shown that what might be called mass action, i. e., the actual number of bacteria exposed to the action of the antiseptic in the test tube, has a very important bearing on the efficiency. The presence of organic matter other than the bacteria has naturally a protective action in favor of the bacteria: various mixtures of bacteria with blood serum, whole blood, pus, muscle extract, etc., have been employed to reproduce as far as possible conditions likely to be met with in a wound. For our tests we decided to use pieces of heavily-infected tissues which were exposed for definite periods to a large volume of the antiseptic solution. The tissue after treatment was washed free of the antiseptic with successive quantities of sterile water, and in cases where it was deemed necessary any residual antiseptic was neutralized by appropriate chemical methods. The tissue was then put into a tube of sterile broth and incubated: readings were taken at 24, 48 and 72 hours.

The antiseptics tested were those in use at the military hospitals in Edinburgh and others which have been more or less in general use: they were phenol, acrosyl, kymol, chinosol (oxyquinoline potassium sulphonate), hydrogen peroxide, mercuric iodide, tincture of iodine, potassium permanganate 4%, methylated spirit, turpentine, salicylic acid, sodium salicylate, methyl salicylate (oil of wintergreen), glycerin, bleaching powder, bleaching powder and hydrogen peroxide (for nascent oxygen), eau de Javelle, boric acid. Our test proved very drastic: of the above only bleaching powder, 10% solution, eau de Javelle (10% sodium hypochlorite), 5% phenol, and the mixture of bleaching powder and hydrogen peroxide had any effect in delaying or inhibiting growth, and the first two were decidedly ahead of the others. The hypochlorites were thus proved, as has often happened before, to be the strongest antiseptics in general use. There are other points decidedly in their favor. Bleaching powder is cheap, easily procured anywhere, and above all it cannot be classed as a dangerous poison. On the other hand, pure *Liquor calcis chlorinatae* and eau de Javelle are very drastic remedies and on account of their strong alkalinity and high chlorine content (about 3% available chlorine) the tissues will not stand their continued application: for this reason they have never come into general use, though they have both been used with great success on occasion. For instance, in 1846 Semelweiss, an Austrian physician, stamped out an epidemic of sepsis in his hospital in Vienna by using bleaching powder. Pasteur used *Liquor calcis chlorinatae*, and I am informed by Sir James Russell that when he was a medical student in this university Professor Spence constantly used it. Our problem thus reduced itself to getting bleaching powder into a solution or powder that could be applied to open wounds without damaging the tissues unduly.

Following our original method, i. e., with infected tissues, and using mixtures of varying proportions of boric acid and bleaching powder with small quantities of water, we found that with equal quantities of each we got a most pungent smelling paste which had no difficulty in sterilizing the tissue and, on the other hand, apart from bleaching, did not seem to damage it as much as was expected. We also found that the gas (hypochlorous acid) given off by this mixture was capable of sterilizing highly infected tissue, provided it was allowed to act long enough: in some of the experiments two hours was sufficient. This mixture, therefore, gave promise of high value as a wound dressing, and I shall have occasion to refer to it later. Solutions prepared from this mixture were next tested and very interesting results were brought out; the bactericidal efficiency of the solution was greatly increased; instead of 3.5% available chlorine, as in *Liquor calcis chlorinatae*, one-tenth of that amount gave very satisfactory results, the free hypochlorous acid proving a much better germicide than the calcium salt.

Further test experiments were carried out with anthrax spores, one of the most virulent and resistant of pathogenic organisms; we were gratified to find that our solution in a strength of 0.35% available chlorine killed the spores in one minute.

Turning next to the action on living tissues, working first on rabbits, then on ourselves, then on patients in local hospitals, we were soon convinced that hypochlorous acid in a solution such as ours could be applied to tissues in a strength hitherto unsuspected. Large quantities of the solution can be applied to extensive wound surfaces, and may be freely introduced into the peritoneum or pleural cavity without producing any toxic effect; indeed the mixed powders may be introduced into wounds and even into the peritoneal cavity without damaging the tissues; such treatment has been found very effective in grossly infected wounds.

Pure hypochlorous acid in aqueous solution always contains free hydrochloric and chloric acids due to spontaneous decomposition, one molecule of hypochlorous acid being oxidized to chloric acid at the expense of other two molecules which are reduced to hydrochloric acid. Both are very strong acids and therefore pure hypochlorous acid is not suitable for wound treatment.

By adding boric acid to chloride of lime in the proportions above stated we have produced a solution containing calcium biborate, an acid salt of extremely low hydrogen ion concentration; on mixing such a solution with one containing hydrochloric acid, the acidity is reduced as the free $H^{\cdot}$ ions are taken up by the boric ions forming H_3BO_3; the acidity of the solution therefore cannot rise above the dissociation constant for boric acid, which is very low.

By this adjustment various advantages have been secured; the alkalinity of the chloride of lime has been reduced, the full effect of the free hypochlorous acid has been secured, and the solution cannot become unduly acid. In virtue of this balance it follows that the solution can be applied freely to the tissues of the body, and that a considerable quantity can be injected into the circulating blood without harmful effect.

The high germicidal value of pure hypochlorous acid solutions was demonstrated in 1903 by Andrews and Orton.[3] In test-tube experiments they found that very weak solutions of hypochlorous acid, 1 part in 100,000, would kill pathogenic organisms in one minute, but when applied to solutions containing organic matter as well as bacteria they found the hypochlorous acid so rapidly destroyed that they did not evolve any method of applying the solution as a practical antiseptic.

Putting all the above observations together we fixed on the following as safe antiseptics:

The powder, equal weights of chloride of lime and boric acid. The solution, prepared by shaking up 25 grms. of the above mixture in one liter of water and filtering off the sediment; this solution contains about 0.26% hypochlorous acid. The powder we named Eupad and the solution Eusol—words derived from the initial letters of Edinburgh University Pathology Department.

A simple and convenient method of preparing small quantities of Eusol is to make it up from *Liquor calcis chlorinatae*, that is 10% chloride of lime; this solution, contrary to the statement in the Pharmacopœia, keeps very well if stored in a cool dark cupboard. I have kept it for months in the laboratory with a very small loss of chlorine. This solution may be made in quantity, say, two liters, filtered clear, and the chlorine content determined; the amount necessary for one liter of Eusol is easily calculated; with a good chloride of lime this should be about 125 c.c. which is diluted to one liter, and shaken with 10 grms. of boric acid; the solution remains clear.

For testing we recommend $N/10$ sodium arsenite solution; this solution keeps better than sodium thiosulphate; it is also better for testing bleaching powder, as chlorates do not interfere with the result, as they do in the hydrochloric acid and potassium iodide method.

Another hypochlorite solution has also been introduced as an antiseptic. It is known as Dakin's[4] solution and contains sodium hypochlorite and sodium bicarbonate; its action is much the same as that of Eusol but it is decidedly alkaline.

As Eusol is a most powerful oxidizing agent it is evident that its value as an antiseptic will soon be reduced in contact with organic fluids such as are en-

*From the *Journal of the Society of Chemical Industry*.

[1] Lorrain Smith, Drennan, Rettie, and Campbell. *B. M. J.*, 1915, 2, 129.

[2] Chick and Martin. *Journal of Hygiene*, 1908, 8, 654.

[3] F. W. Andrewes and K. J. P. Orton. Cent. f. Bakt., 1903-4, 35. Abt. 1, pp. 645 and 811.

[4] Dakin. *B. M. J.*, 1915, 2, 318.

countered in an open wound; therefore in order to bring any effective solution into contact with the organisms hidden in the depths of the wound, large quantities must be used and the solution got down to the lowest recesses and pockets. To accomplish this, surgeons have various appliances with rubber tubes branching from a common source of supply; this method was applied most successfully with Eusol by Captain Miles[5] in Edinburgh and also by Captain John Fraser[6] in France. A similar method has been advocated by Carrel, who worked with Dakins' solution at Compiegne, and constitutes the Carrel-Dakin[7] method of wound treatment.

We have further observed in open wounds a distinct outpouring of lymph on the application of Eusol, thus combining the advantages of the hypertonic saline treatment with the killing power of the hypochlorous acid; here also the nontoxicity of the solution tells strongly in its favor; there are no toxic by-products at all. Carbolic acid is an excellent antiseptic, but if applied to a wound in unlimited quantity it very soon produces necrosis and may even produce symptoms of general poisoning. The cresols and emulsions containing them precipitate a sticky film of resinous matter in the wound, clogging it and preventing free drainage.

In the course of our preliminary experiments on the effect of Eusol on live tissues we found that large quantities, as much as 40 to 50 c.c., could be injected into the blood stream of rabbits without injuring the animal; following up this line of investigation, with a view to attacking sepsis in the blood, we have met with a considerable measure of success. We applied this method of treatment in the first instance to a case of puerperal septicæmia in the Maternity Hospital in this city.[8] The patient was suffering from an extremely grave form of blood poisoning; the treatment was completely successful.

Following on this, Captain John Fraser, R. A. M. C.,[9] applied the same treatment to soldiers suffering from the acute toxæmia arising from wounds infected with the gas-producing organisms—*Bacillus Welchii*, *B. sporogenes*, etc. These organisms, which cause what is known as gas gangrene, owing to the fact that they produce large quantities of gas inside the tissues, are the scourge of the casualty clearing stations; they are spore-bearers and therefore difficult to kill and the spores are present everywhere.

In certain types of gas gangrene toxæmia, Captain Fraser found intravenous Eusol as strikingly successful as in our first case, but in others it did not seem to have any effect; and this has been the experience of all workers who have employed the method. Sir Herbert Waterhouse[10] in his report from Anglo-Russian Hospitals, says: "We entertain the highest opinion of its value as a life-saving method in many apparently hopeless cases of septicæmia and pyæmia." This treatment was the subject of much investigation under our own care at the Sick Children's Hospital in Edinburgh. A paper on the subject was published in the *Edinburgh Medical Journal*[11] this summer. As a result, we found that evidence of benefit was recorded in cases of lung infection, such as broncho-pneumonia, empyema, abscess of lung; in toxæmia from appendicitis, and in one case of toxic diarrhœa, also in cases of chronic meningitis. No benefit accrued in cases of rheumatism or in tuberculosis.

The problem we are now engaged on is to find out why in certain bacterial infections we can help the recuperative powers of the body and in others we cannot. We may be acting on a toxin produced by the bacteria and circulating in the blood, or we may destroy some toxic agent formed by the blood itself, or may merely stimulate a protective reaction in the body fluids. Many theories have been advanced as to the conditions found in acute toxæmia. A toxin of protein origin has been held accountable. Again, an increase in the acidity of the blood, due to the production of butyric and kindred acids by the bacteria. A later suggestion by Wright is that the antitryptic power of the blood is reduced; this allows the trypsin to prepare a suitable medium for the growth of the bacteria in the blood itself and the patient is overwhelmed by an acute invasion of the actual organisms. The subject is much too large to enter into in a paper like this. I merely indicate it to show the sort of problems that the chemist is asked to solve in pathological or physiological chemistry.

Take the question of toxins. In a rabbit of 2 kilos. weight there is, say, 100 c.c. of blood. Such a rabbit can stand without inconvenience, say, for a very safe estimate, 20 c.c. Eusol intravenously; this contains 0.05 grm. HClO; obviously 0.05 grm. of hypochlorous acid in 100 c.c. of blood can have no possible action as a direct antiseptic. On the other hand, ricin, a vegetable protein poison extracted from castor oil beans, very closely resembling the bacterial toxins, when administered intravenously to a 2-kilogram rabbit in a dose of 0.001 mgrm., kills the animal. A very small amount of hypochlorous acid would suffice to neutralize this dose, if it could reach it.

Hitherto the treatment of conditions due to organic toxins has been based on the conception of a specific antidote; for example, take diphtheria. The method of treating the disease is to inject into the patient the serum of an animal which has been rendered highly immune to the diphtheria toxin. This serum has the power of neutralizing the toxin, but it is a specific power; it cannot neutralize the toxin produced by other organisms, e.g., tetanus. The interest of the method of treatment by intravenous injection of hypochlorous acid lies in the fact that we are able to introduce into the blood a considerable quantity of a strong chemical reagent which will act in a general and not a specific manner.

The chemical reaction between hypochlorous acid and blood is naturally very complex. When hypochlorous acid or hypochlorites act on proteins, the first products are chloramines. In these compounds, which have been studied by Chattaway, Langheld and later by Dakin, chlorine displaces the hydrogen attached to the nitrogen, giving compounds containing the group NCl. These substances give the reactions for free chlorine and are themselves antiseptics of considerable value. As they are formed in the wound or in the blood stream in intravenous injection, and may continue to exist as such for some time, they may prove to have an important bearing on the reactions of the body. They ultimately break down to aldehydes, nitriles, carbon dioxide, ammonia, etc. Work on these compounds as antiseptics has been carried out by H. D. Dakin[12] and others working in Professor Cohen's laboratory at Leeds, and two chloramine antiseptics have been prepared and are now in extensive use. They are known as chloramine T, which is *p*-toluene sodium sulphochloramide, $CH_3C_6H_4SO_2NaNCl$, and dichloramine T, toluene-*p*-sulphodichloramine, $CH_3C_6H_4SO_2NCl_2$. The former is soluble in water and is used in a strength of 0.5%. The dichloramine is insoluble but dissolves in eucalyptol, which is then diluted with paraffin oil.

In the exigencies of war surgery a large variety of antiseptics, including several synthetic dyes, have been tested, but the general conclusion seems to be that hypochlorous acid, one of the oldest antiseptics, still remains the most reliable for general wound treatment.

In Eusol the full value of hypochlorous acid is available without the drawbacks inherent in the earlier solutions containing this potent reagent.

[5]Miles. *Edin. Med. J.*, Feb., 1916.

[6]Fraser. *B. M. J.*, Oct. 9th, 1915. *Ed. Med. Journal*, March, 1916.

[7]Sherman. Hypochlorite Solutions for Wound Treatment. *B. M. J.*, 1916, 2, 621.

[8]Lorrain Smith, Ritchie, and Rettie. *B. M. J.*, 1915, 2, p. 716.

[9]Fraser and Bates. *B. M. J.*, 1916, 1, 83.

[10]Sir H. Waterhouse and others. *B. M. J.*, 1917, 2, 441.

[11]Lorrain Smith, Ritchie, and Rettie. *Ed. Med. J.*, Sept., 1917.

[12]Dakin and others. Proc. Roy. Soc., 1916, B 89, 232 and *B. M. J.*, 1917, 1, 865.

For clinical trials with Eusol see Lancet., Feb. 5 and 12, 1916.

Some Needed Reforms in Commercial Enlarging Lanterns

In our idea the enlarging lantern should be constructed of metal and asbestos as far as possible. Wood is bulky, liable to warp and burn, and expensive to work. One can make stampings which require little finishing, and an asbestos lining is fireproof, non-conductive of heat, and a protection against short circuiting with electric lighting. The lamp house, as the cinematographer terms it, may conveniently be of cylindrical form, as in one of the American models, the tube being exactly the diameter of the condenser. This is provided with the necessary ventilating apertures and a bed on which the small half-watt lamp can be moved to and fro. The stage to receive the negative should be capable of adjustment so that thick or thin carriers could be used at will. This would allow an arrangement for tilting the negative to be incorporated in the carrier. It would also allow of a small negative being brought further away from the condenser so that it received a greater quantity of light than if it were placed in the usual position. In the case of large lanterns, it is desirable to have smaller condensers interchangeable with the full-sized ones. It is much more convenient to enlarge or reduce from quarter-plate negatives with a 6-inch condenser and appropriate lens than to use an 8-inch diameter for this size.

The arrangement of nearly all the focussing devices is wrong. We have tables of conjugate foci giving distances between lens and paper and lens and negative, and we try to put them into practice by moving the lens instead of the negative. The new enlarger must have an adjustment by which after setting the distance between lens and paper we can move the condenser, negative and light (all together) to obtain a sharp image. With existing patterns with their wooden beds and badly fitting grooves this would be difficult, but with a well-made metal bed it would be quite easy. The best way of effecting this would be to have the whole apparatus on a gantry or base (the lens-board, condenser, and lamp-house being capable of independent motions thereon). The front portion carrying the lens should be fitted with an efficient clamp, so that it would not be disturbed when the negative and condenser were moved to and fro for focussing. It would be an improvement if the negative carrier were detached from the condenser frame, a few folds of bellows intervening; this would allow a small negative to be brought forward so as to receive nearly the whole of the cone of rays from the condenser.

Another point which has been overlooked by nearly all makers is the provision of some means of bringing any part of a large negative opposite the center of the condenser. This was done some years ago by the London Stereoscopic Company, who issued a book-form carrier in which the negative was held by friction between two frames hinged together. In the quarter-plate size any portion of a whole-plate could be accurately squared-up opposite the center of the condenser. As it is, makers give a little rise and fall, though much more sideway movement. It would seem that they regard these adjustments as intended to move the projected image in the easel—not their only purpose. In any case the slot in which the negative carrier slides should be open at the top and have sufficient depth at the bottom to allow the center of a 12 x 10 negative to be placed opposite the center of a 5½-in. condenser. This is frequently required when a single figure has to be enlarged from the center of a group.

The length of the bellows is another matter which is not generally considered as closely as it should be. Nowadays enlarging lanterns are very commonly used for reducing as well as for the purpose they are primarily intended for, and it is very necessary that sufficient length of bellows should be provided for this purpose. We have adapted an ordinary cantilever pattern by making an extension cone to fit in place of the lens panel, thus obtaining an extra draw of twelve inches, but this would be much better done by providing a longer bellows in the first place.

To equalize the light and to soften it so that retouching marks and scratches do not show on the print it is very desirable that arrangement should be made to interpose a piece of very fine ground glass between the lamp and the condenser. It serves as well to destroy the image of the filament or incandescent mantle so often evident when the light is in its best position. Quite a small piece placed close to the light is all that is necessary. When ground glass is used in this way the action of the diaphragm in reducing the amount of light transmitted comes into play. The area of the illuminant is increased, the ground glass itself being practically the source of light as far as the optical system is concerned. Hence the cone of rays from the condenser will not pass through a comparatively small aperture, but requires a large one if short exposures are necessary. From actual trial with a small arc lamp it was found that the entire cone of rays emerging from the condenser passed through the condensing lens at an aperture of $f/16$, but when a ground glass was interposed a perceptible diminution of light was apparent at about $f/10$. Trial exposures then showed that with apertures up to $f/45$ the giving of the standard increase of time to each yielded practically equal results, but with additional contrast, as might be expected as with ordinary camera exposures.—*British Jour. of Photog.*

Revenue by Thawing Frozen Water Pipes

Owing to the extremely cold weather which has recently been experienced in Binghamton (N. Y.) and vicinity, there have been a great many applications made to the Binghamton Light, Heat & Power Company for thawing out frozen water pipes. During the week, January 5th to 12th, there were 80 requests for this class of work. The company's methods of accomplishing these thaw-outs have been very successful and it is a source of considerable revenue. The minimum charge for the work is $10 per service, to which is added $1 for each mile that the customer is from the stock room, $1 for each 100 feet that it is necessary to run service wires, and $1 for each half-inch increase in size of pipe over 1½ inches. The average return from thawing a pipe is approximately $13, which is about one-quarter of what it would cost to do this work by other methods.—*Electrical Review.*

A Glass Polarimeter

A Simple Instrument for Illustrating the Laws of Optical Rotation

By G. A. Shook, Williams College and C. V. Kent, University of Michigan

A SIMPLE polarimeter which will, at least, illustrate the laws of optical rotation can easily be constructed by means of two Nicol prisms, or could when Nicols were obtainable. If we were to substitute for the two Nicol prisms two piles of glass plates it is at once evident that no result, to speak of, could be obtained due to the imperfect polarization that exists in a beam of light transmitted through a pile of plates.

Several years ago, however, Dr. C. V. Kent, of the University of Michigan, developed a new type of variable sensibility bi-field which can easily be constructed of glass plates, and the adapting of this bi-field to a polarimeter, utilizing glass plates instead of Nicols, immediately suggested itself.

The arrangement of the glass plates and other optical parts that seemed to yield the best results is that shown in Fig. 1.

The polarizer P consists of two piles of glass plates, R and S, each pile containing 10 microscope slides of about 1.5 mm. thickness. By using two piles of 10 plates each, arranged as shown, instead of one pile of 20 plates, the beam of light is symmetrical with respect to the axis of rotation of the polarizer. Each pile makes an angle of 30° with this axis. They are clamped, as shown, to a plate which can be rotated about the optical axis of the lens system, and to one end of this plate is attached a circle for measuring the angle of rotation of the optically active substance under consideration.

Light from a sodium flame first passes through a condensing lens L, then through this glass polarizer to the tube T and thence to the bi-field B. A complete theory of this bi-field need not be given here, as it is not the object of this paper. The general idea is as follows:

Two similar pieces of glass, M and N, are cut as indicated in Fig. 2.

Microscope slides have been used with success, and even a poor quality at that. The inner edge, V, of each plate should be ground sharp, but it is immaterial with the outer edge as the light passes through the bi-field in the direction indicated, so that the edge U will not be visible. The two pieces should be clamped together as shown, so that the inner edges make good contact, for the photometric field is divided by this common edge. As it is very difficult to make a sharp dividing line by bringing the two inner edges close together, it is better to have one edge overlap the other, as shown. The field is then divided by this overlapping edge. In this case it is not necessary, of course, to have both edges perfectly sharp.

Now consider two beams of plane polarized light, each of amplitude R, incident upon the two plates of the bi-field as shown in Fig. 3. Considering either plate, R may be resolved into two components, X and Y; the former in the plane of incidence and the latter perpendicular to the plane of incidence. That is, X strikes the plate obliquely while Y lies in the plane of the plate.

The transmitted components will of course be less, due to reflection and absorption, but they will not be diminished in the same ratio as Y (being in the plane of the glass plate) loses more by reflection than X does, so that R is not only diminished but slightly rotated. Looking toward the light the condition of affairs is that shown in Fig. 3. The two transmitted components are X′ and Y′, and their resultant is R′.

If now the plane of transmission of the analyzer is perpendicular to the plane of intersection of the two plates, *i. e.*, perpendicular to OP, then the component of R′ which illuminates half the field is Q. We have here evidently just the condition that obtains in all bi-fields. The plane of the analyzer might just as well be parallel to OP, but in this instrument it is more convenient, as will appear later, to have it perpendicular.

In order that the bi-field be sensitive, it is necessary that Q be small compared with R′, and this condition obtains when the angle between the plates is large and the angle of elevation of their common edge is nearly 90°.

The bi-field is viewed by an eye lens E, Fig. 1, and beyond this eye lens is the analyzer A, which consists of 20 microscope cover glasses. Finally between the analyzer and the eye is a diaphram. The field is also improved by inserting a field lens F, of long focal length, and it is also desirable to have a diaphram, D, as close to the common edge as possible. In the case of the analyzer a much better field was produced with reflected light than transmitted light, and incidentally this arrangement affords a more natural position for observing.

As to the sensibility of such a polarimeter a single observation can easily be made within 0.1° with the

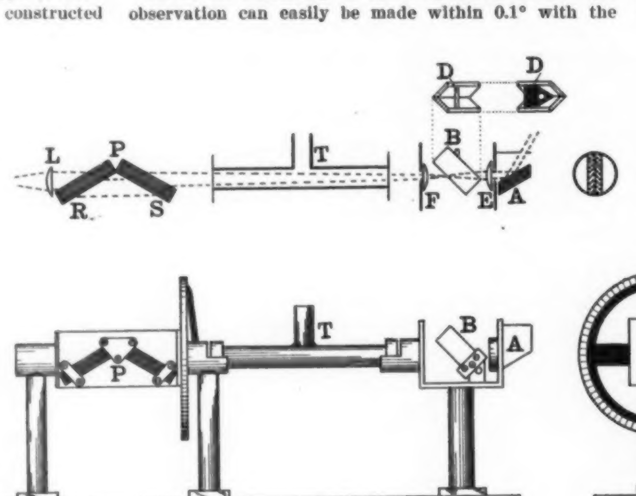


Fig 1. Optical system of the Glass Polarimeter

instrument constructed by Dr. Shook, and while this is far from the requirements of industrial practice, it is not improbable that in the hands of an instrument maker this sensibility might be considerably increased, and if longer tubes and greater concentrations could be used the final accuracy would be sufficient for ordinary use.

In the usual form of polarimeter long tubes are prohibitive, as the field cannot be sufficiently illuminated. The loss of light is due to two things: In the first place a Nicol with a clear aperture of 1″ would

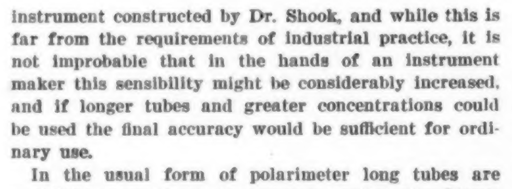


Fig 2. Bi-field plates

cost not less than $50, and there are not many large Nicols to be had at any price, as large pieces of clear calcite are not often found. It is therefore impractical to use large apertures and large fields, while with the glass polarimeter the cost of a glass polarizer would not exceed 5 cents, and hence larger apertures can readily be used. Secondly, the field, in the usual form of polarimeter, is so far from the eye that it cannot be examined with an eye-lens, and this causes another considerable loss of light.

As far as the illumination is concerned, there is no

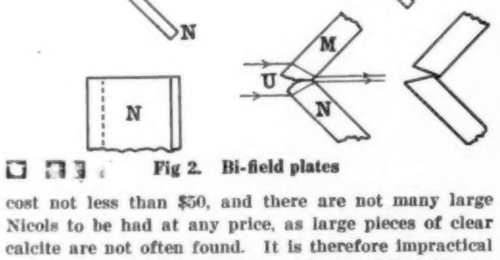


Fig. 3. Variable sensibility bi-field

reason why this instrument cannot be built to utilize 1,000-mm. tubes.

The glass polarimeter was also used with white light. A monochromatic red glass was placed over the last diaphram, *i. e.*, next to the eye, and it was found that a setting could be made as accurately as with a sodium light. This arrangement might prove very satisfactory for physicians, as it requires little attention.

The light was a 25-watt frosted globe tungsten lamp placed about 10 cm. from the end of the instrument. No objective lens is needed in this case. The lamp was well housed and made an integral part of the polarimeter so that it would not have to be constantly adjusted.

Recovery of Light Oils from Coke-Oven Gas

THERE are at present 43 plants in the United States recovering light oils, with an approximate output of 110,000,000 gallons as against 10,000,000 gallons in 1913. The first attempt to recover benzol was made by Vogel in 1859, fatty oils being used for absorption with the idea of increasing their value for illuminating purposes. A patent was taken out by Carvès in 1884 for the recovery of benzol in connection with his coke ovens, heavy tar oil being used in an intermittent process. The first continuous plant of any size was built by Brunck in 1894. The general type of scrubber used appears to be of the tower form, from 6 to 24 feet in diameter, and 40 to 90 feet high, uniformly filled with wood grids. Experience has shown that it is desirable to have not less than three towers in a series, the wash-oil being circulated in counter-current to the gas, and in sufficient quantity to bring about a saturation of the benzolized oil to about two or three per cent. Tar oil is used as an absorbent in Europe, and high-boiling petroleum oils in the United States. Plants at which still temperatures of about 135 degrees C. are obtained show better wash-oil results than plants working at lower temperatures. The time of contact of the gas and oil in the majority of plants is from 70 to 100 seconds. The absorbing power of the oil commences to drop off very rapidly at about 25 degrees C., so that it is important to keep the temperatures of gas and wash oil below this figure. In European plants the benzolized oil passes first through an oil-to-oil heat exchanger, then through a vapor-to-oil exchanger, while in America this sequence is reversed. Experience has fully demonstrated the desirability of the use of superheated steam. The author suggests the use of the single-pipe refrigeration ammonia cooler for cooling the wash oil, also that the cooling be brought about with the wash oil inside the tubes, and water outside, down to about 40 degrees F. (4.5 degrees C.), and the remainder of the cooling with oil outside and water inside. The reduction in heat value and illuminating power is given as 10 B. Th. U. and 2.3 candles respectively per 0.1 gall. of light oil removed per 1,000 cubic feet.—Abstract from a paper by W. H. WRIGHT in *Am. Gas Inst.*

Two Ancient Bronzes

SIR C. H. READ describes in *Man* for January, two bronzes acquired from a Parsi in Bombay, who stated that his family had possessed them from time immemorial, and that they had been brought by one of his ancestors from Persia, where they had been attached to the gate of the city whence the Parsi family had come. They are castings by the wax process, known as *cire perdue*, and represent animals which at once recall the bull-like monsters of Assyria; but, at the same time, there are differences that may be of some significance. The Assyrian bulls are human-headed, and these also have human heads, but while the modelling of the bodies suggests a bull, the horns are unquestionably those of a sheep. This sheep has been identified by Lord Rothschild as *Ovis orientalis gmelini*, the wild sheep of Asia Minor and Armenia. It is possible that these bronzes were ultimately derived from Assyria, and as the relations between Assyria, Persia and Armenia were intimate, the story of the Parsi may be correct. But many questions regarding the style and use of these bronzes, which will ultimately pass to the British Museum, await further investigation.—*Nature.*

The Oldest Flint Implements*

A Study of the Methods by Which They Were Produced

By J. Reid Moir, F.R.A.I.

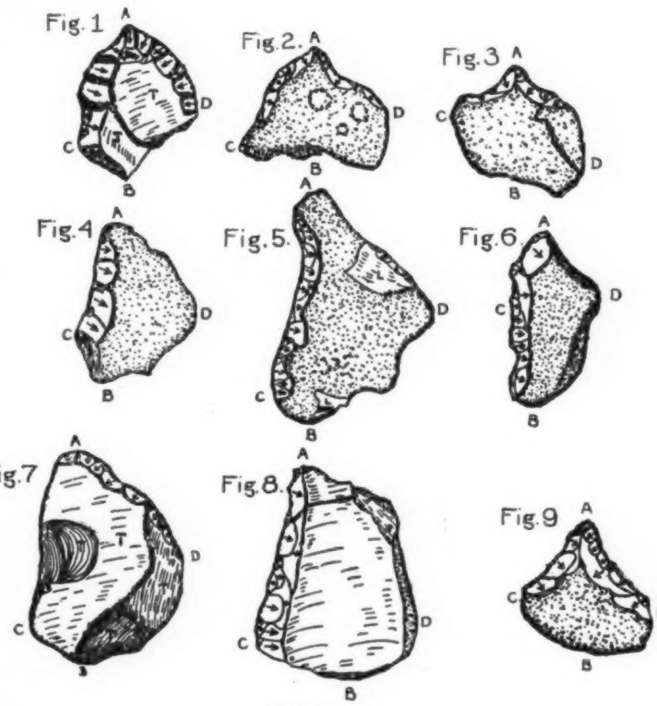
In a former article in *Science Progress* ("Flint Fracture and Flint Implements,"[1] July, 1916, pp. 37-50) the present author was privileged to give some account of the past and present position of prehistorical research, and to describe a number of experiments in the fracture of flint, which were carried out with the object of providing prehistorians with some satisfactory data upon which to base their acceptance or rejection of any series of flaked flints as being humanly fashioned. It is proposed in the present article to apply the criteria furnished by the above-mentioned experiments to a series of very primitive and ancient flaked flints first discovered by Mr. Benjamin Harrison in the high plateau gravel of Kent, and which have been the cause of much disagreement and disputation amongst archæologists. Without troubling the reader with the somewhat complex geological facts which demonstrate the great antiquity of these primitive flaked flints, it may be stated that the deposits in which they mostly occur pre-date, by a considerable period, those in which the earliest implements of river-drift, or "palæolithic," man are found, and in consequence of which the chipped stones recovered from these very ancient deposits have been rendered suspect by those who hold conservative views upon the question of man's antiquity. But it must be pointed out that those who believe that these very ancient flaked flints are humanly fashioned may with equal justice be said to hold extreme views in favor of the high antiquity of man, and unless either school can bring forward definite scientific facts in support of their respective opinions, those opinions must be regarded as being of very little real value. The author does not propose therefore to enumerate the various "reasons" which have been advanced in the past for the rejection or acceptance of these particular specimens. He proposes to confine his remarks solely to the characteristics of the flaking exhibited by them, and by comparing it with that produced on other stones—on the one hand by means of fortuitous percussion and pressure, and on the other by blows delivered with a hammer-stone used in the ordinary "human" manner—to decide whether these very primitive flints have been flaked by man, or by the unguided forces of nature. But it may be as well, before proceeding to describe the specimens selected for illustration, to give the reader some idea of the general appearance of these primitive edge-flaked flints.[2] They are usually of a more or less tabular form, the whole of one side of which very often exhibits the original crust or cortex of the flint, while the whole of the other is represented by the hard interior owing to the specimen having been split by some disruptive force, which very frequently, but not always, can with some confidence be described as being of thermal origin. The edges of these tabular flints have then been trimmed by somewhat steep flaking so that the specimens assume a pointed form (Figs. 1, 2 and 3), or are provided with a more or less straight cutting edge (Figs. 4, 5, and 6), and it has been suggested by those who regard these specimens as being humanly fashioned, that such forms might have been used by a primitive race of people for boring and scraping purposes.

The color of the flaked and broken surfaces of the specimens is generally reddish-brown, some being of a darker shade than others. They very often show signs of having been subjected to rolling by water, which has had the effect of rounding the sharp edges and angles of the flints, and of imprinting upon their surfaces incipient cones of percussion due to the impact of other stones. Very frequently, too, the specimens exhibit striæ on one or other of their flat surfaces, showing that at some period of their history they have been subjected to a slight amount of pressure. There can be no doubt that it is of importance to make a really dispassionate study of these primitive edge-flaked stones, as their antiquity is undoubted, and if of human origin, they represent man's first efforts to shape flints to his needs.

The author has had various opportunities during the past few years of critically examining a number of these ancient flints, and has selected six (together with three others) from his own collection for illustration in this paper. In the delineation of these specimens a severely diagrammatic style has been adopted, but each flake area is faithfully outlined, and the arrows which indicate the direction in which the force acted which removed the flakes have been put in with very great care.

DESCRIPTIONS OF THE SPECIMENS

Fig. 1.—Found in a gravel-pit in the occupation of Messrs. A. Bolton & Co., Ltd., Henley Road, Ipswich. The gravel occurs at a height of about 120 O. D., and forms one of the plateau series of deposits. It is generally supposed to be intermediate in age between the early glacial Contorted Drift of Cromer and the glacially deposited Chalky Boulder Clay. The specimen, and others of the same order from the gravel, have evidently, by their condition, been derived from some still more ancient deposit which at some remote period was broken up and redeposited.



FIGS. 1 TO 9.

The flaked areas of the flint are light chestnut-brown in color, and the side opposite to that figured is formed of unflaked cortex which is extensively coated with a deposit of what appears to be manganese. The major fractures (marked T in the illustration) are almost certainly of thermal origin, while the edge flaking which has given to the stone the well-marked pointed form is considered, for reasons which need not be given here to be the result of blows. The specimen, which measures in greatest length (A—B) 2¼ inches greatest width (C—D) 2⅛ inches, greatest thickness ⅝ inch, exhibits neither scratches nor incipient cones of percussion upon its flaked surfaces. The edges and angles of the flint are somewhat smoothed, possibly by the action of running water.

Fig. 2.—Found in the high-level plateau gravel of Kent. The exact geological age of this deposit, though undoubtedly extremely ancient, is still in debate, and as it does not contain any fossiliferous remains, it is possible that it may never be satisfactorily dated. The flaked areas of the specimen range in color from yellowish-white to yellowish-brown. The upper surface is formed almost entirely of unflaked cortex which is of a dark brown color. The under-surface, which appears to be attributable to thermal breakage, exhibits the hard interior of the flint, and is extensively scored with small striæ which follow very erratic and non-parallel courses. The edge-flaking, which has given to the stone the well-marked pointed form, is considered to be the result of blows. The specimen, which measures in greatest length (A—B) 1¾ inches, greatest width (C—D) 2 7/16 inches, greatest thickness ⅝ inch, exhibits no incipient cones of percussion upon its flaked surfaces, nor does it show any signs of having been subjected to the action of running water.

Fig. 3.—Provenance the same as specimen represented in Fig. 1. This specimen (Fig. 3) has been made from a piece of tabular flint, and its upper and lower surfaces are represented by unflaked cortex. The flaked areas of the specimen are of a deep cholocate-brown color, and exhibit a well-marked glaze. The edge-flaking, which has given to the stone the well-marked pointed form, is considered to be the result of blows. The specimen, which measures in greatest length (A—B) 1 11/16 inches, greatest width (C—D) 2⅛ inches, greatest thickness 11/16 inches, exhibits neither incipient cones of percussion nor striæ upon its flaked surfaces, nor does it appear to have been subjected to the action of running water. The original surfaces of the flint, which are more ancient than the flaking which has produced the present pointed form, show, however, some little amount of abrasion.

Fig. 4.—Provenance the same as specimen represented in Fig. 2. This specimen (Fig. 4) has been made from a piece of tabular flint, and its upper and lower surfaces are represented by unflaked cortex. The flaked areas of the specimen are of a chocolate-brown color. The edge-flaking, which has provided the flint with a more or less straight cutting edge, is considered to be the result of blows. The specimen, which measures in greatest length (A—B) 2⅜ inches, greatest width (C—D) 15/16 inch, greatest thickness 1 inch, exhibits a few incipient cones of percussion upon its flaked surfaces, and some small striæ are to be seen upon some of these surfaces. It would appear that the specimen has been subjected to some amount of rolling by water action, as the edges and sharp angles of the stone are somewhat abraded.

It is, of course, possible that some of this abrasion may have been caused by the slight amount of pressure to which the stone has been subjected, and to which the small striæ mentioned bear witness.

Fig. 5.—Provenance the same as specimens represented in Figs. 2 and 4. This specimen (Fig. 5) has been made from a piece of tabular flint which exhibits unflaked cortex over nearly the whole of its upper surface. The lower surface exhibits the hard unflaked interior of the flint, and is made up of several fracture surfaces which have in all probability been produced by thermal action. The under surface of the stone is of a chestnut-brown color, while the upper unflanked surface is of a *café-au-lait* shade. The edge-flaking, which has provided the flint with a more or less straight cutting edge, is considered to be the result of blows. This edge flaking exhibits a well-marked glaze, it is not stained, and shows the almost unchanged black interior of the flint. The specimen, which measures in greatest length (A—B) 3 7/16 inches, greatest width (C—D) 2 13/16 inches, greatest thickness, 1 inch, exhibits no incipient cones of percussion upon its surfaces, but the lower thermally broken surfaces exhibit a few small striæ. The stone appears to have suffered some amount of abrasion, but at a time prior to that to which the edge-flaking is referable. The flaked areas marked L in the illustration are recent fractures.

Fig. 6.—Provenance the same as specimens represented in Figs. 1 and 3. This specimen (Fig. 6) has been made from a tabular-shaped nodule of flint, and exhibits unflaked cortex over the whole of its upper and lower surfaces. The upper surface of the specimen is lightish-brown in color, while the lower shows little or no staining. The edge-flaking, which has provided the flint with a more or less straight cutting edge, shows a well-marked glaze, and is considered to be the result of blows. The flaked areas of the stone are toffee-colored. The specimen, which measures in greatest length (A—

*Reproduced from *Science Progress*.

[1] *Scientific American Supplement* No. 2187, Dec. 1917.

[2] These specimens have been known to archæologists as "Eoliths" (*eos*, dawn, and *lithos*, stone), but as some observers have used this term to describe any piece of roughly broken flint, it is necessary to adopt a more precise nomenclature.

B) 2 11/16 inches, greatest width (C—D) 1 7/16 inches, greatest thickness ⅝ inch, exhibits neither incipient cones of percussion nor striæ upon its surfaces. The flint shows little or no signs of abrasion.

Fig. 7.—Found upon the sea beach at Lowestoft, Suffolk. This specimen, which is of a dark chocolate-brown color, with a slight bluish tinge upon its upper surface,[1] has been formed, so far as its larger fracture surfaces are concerned (marked T in drawing), by thermal action. The edge-flaking, which is of a different order from that exhibited by the specimens hitherto described, is considered to be the result of blows. The specimen, which measured in greatest length (A—B) 3 5/16 inches, greatest width (C—D) 2 11/16 inches, greatest thickness 1¼ inches, is heavily abraded and exhibits numerous criss-cross striæ and incipient cones of percussion upon its surfaces.

Figs. 8 and 9.—Represent flints flaked by the author with another stone used as a hammer.

The above description, together with the illustrations, will enable the reader to form a very good mental picture of the specimens under examination, and it is now proposed to apply the criteria obtained in the experiments in flint fracture mentioned above (*Science Progress*, July, 1916, pp. 37-50), and to decide whether the edge-flaking of the specimens illustrated in Figs. 1-7 is of human or natural origin.

The first question for decision is the nature of the force which has produced this edge-flaking, whether percussion or pressure. The author does not consider there can be much doubt that percussion has been the agent of fracture. An examination of the edge-flaking reveals no evidence of the effects of pressure, while all the characteristics of flaking by percussion are, on the other hand, abundantly observable.

There are no "opposing cones of pressure" such as are produced when a stone is subjected to pressure between two resistant surfaces, while the fissures and ripple-marks developed upon the flaked areas are not such as are produced by the effects of pressure. Moreover, the ridges between the flakes are well marked, giving to the flaked edge a somewhat uneven appearance, and it has been ascertained that this prominence of the ridges between the flakes is very seldom, if ever, produced by pressure.[2] It seems, then, that the effects of pressure may be eliminated in our inquiry as to the origin of the edge-flaking of the specimens illustrated in Figs. 1-6, and it is also obvious that Fig. 7 represents a stone edge-flaked by percussion. The scope of the inquiry being thus narrowed down, we may proceed to try to ascertain whether the blows, which were responsible for the edge-flaking upon the specimens mentioned, were delivered by human or natural agency.

The next point to which attention is drawn is the direction of the arrows which appear on each flake area of the flints illustrated. It will be remembered that in the experiment in which flints were subjected to the effects of fortuitous percussion, it was found that the flakes removed from the edges of the stones had been detached at divergent angles, and it was pointed out that while it seemed reasonable to suppose that haphazard blows would strike the edge of a flint at different angles, the flakes removed by a human being, using a hammer stone, would be taken off at a constant angle to the edge.[3]

If the reader will now examine the illustrations accompanying this paper, it will be noticed that while Figs. 1-6 show that the force which acted on the edges of the flints removed the flakes at a constant angle to those edges, Fig. 7, which was picked up on the sea beach at Lowestoft, has had the flakes removed from its edge at divergent angles. It will be noticed also that in Figs. 8 and 9, which represent flints flaked by the author by means of another stone used as a hammer, the specimens have had the flakes removed from their edges at a constant angle. It appears, then, that these flints (Figs. 1-6) have been flaked along their edges by blows, and that these blows have been delivered at a constant angle to those edges. It is also noticeable that Figs. 8 and 9, which represent specimens flaked by the author with a hammer-stone, have had their flakes removed at a constant angle to the edge. The specimen represented by Fig. 7, on the other hand, which was found upon a shingle beach, where natural percussion has opportunities for operating, has had its flakes removed at divergent angles to its edge. This evidence points undoubtedly to the conclusion that the edge-flaking of the specimens illustrated in Figs. 1-6 is of human origin, but we will proceed to a further examination of the flaking to ascertain if this conclusion is supported by other evidence. In the experiment in which flints were subjected to the effects of fortuitous percussion by shaking them in a sack,[4] it was noticed that the flakes removed from the edges of the stones differed in appearance from others removed by human blows. These differences were:

(a) The squatness of the fortuitous flakes as compared with those removed by human agency.

(b) The fact that the former had cut deeper into the flint, causing a step or ledge to appear at the point of their final separation from the parent block.

(c) The occurrence of numerous prominent ripple-marks upon nearly all the flakes produced by fortuitous blows, as compared with their comparative scarcity upon the "human" flakes.

When the specimens illustrated in Figs. 1-6 are examined, it is seen that the flakes removed from their edges are not squat, nor have they cut deeply into the flint, giving rise to a step or ledge at the point of their final separation from the parent block. And in these particulars they agree with the specimens illustrated in Figs. 8 and 9, which were flaked by the author. The edge-flaking of the Lowestoft beach specimen, however, exhibits both the characteristics mentioned and approximates very closely to the edge-flaking produced upon the flints in the sack experiment. The fractures forming the flaked edges of the specimens illustrated in Figs. 1-6 also do not exhibit numerous prominent ripple-marks upon their surfaces, such as are so frequently produced by fortuitous blows, while the Lowestoft beach specimen (Fig. 7) shows well-developed ripple-marks upon five out of its seven flake-areas. In the case of two specimens flaked by the author, prominent ripple-marks upon the flake-areas are very infrequent. It will probably be remembered that in the sack experiment to which reference has been made, it was noticed that the edges of the flaked stones tended to assume a sinuous outline due to blows having fallen upon either side of these edges.

In the specimens illustrated in Figs. 1-6, the blows which have produced the edge-flaking have all been delivered from one side of the flint only, and in consequence no sinuosity of the edge is observable. This is also the case with the specimens flaked by the author (Figs. 8 and 9).

The Lowestoft specimen (Fig. 7) shows a distinct tendency to assume a sinuous outline in its flaked edge, due to blows having removed flakes from both sides of that edge.

The specimens illustrated in Figs. 1-6 do not exhibit an undue number of truncated flakes removed from their flaked edges,[5] and in the case of the Lowestoft beach specimen (Fig. 7) there do not appear to be many developed, though the edge is so battered as to make a certain diagnosis impossible. The specimens flaked by the author (Figs. 8 and 9) do not show an undue number of truncated flakes removed from their flaked edges.

The foregoing examination has shown that the primitive edge-flaked flints illustrated in Figs. 1-6 exhibit the following characteristics which are believed to be associated only with human intention:

(a) The flakes removed from their edges are the result of blows which have been delivered at a constant angle to these edges.

(b) The flakes are not squat, nor do they cut deeply into the flint, causing a step or ledge to appear at the point of their final separation from the parent block.

(c) The flakes do not exhibit numerous and prominent ripple-marks upon their surfaces.

(d) The flaked edges do not exhibit a sinuous outline, nor do they show an undue number of truncated flakes removed in the formation of these flaked edges.

The specimens flaked by the author (Figs. 8 and 9) agree in every particular with the above specimens. The Lowestoft specimen (Fig. 7), found upon a shingle-beach, does not, however, exhibit edge-flaking of the same order as the specimens illustrated in Figs. 1-6, but the flaking approximates very closely to that produced by fortuitous percussion in the sack experiment described. The author is of opinion that the foregoing examination has indicated with some amount of certainty that the primitive edge-flaked flints selected for illustration (Figs. 1-6) are of human origin, and that such specimens deserve the closest attention by all serious pre-historians. But it is to be hoped that, in future, the old unscientific attitude towards these primitive and very ancient flaked flints will be abandoned, and that their acceptance or rejection as the work of man may be based upon some tangible evidence such as has been set forth in this paper. All the specimens illustrated are in the author's possession and can be examined by any one desirous of doing so.

[1]The upper surface of the specimens is the surface which is figured.

[2]See former article, *Scientific American Supplement*, No. 2187.

[3]The methods by which the direction of each blow removing a flake was ascertained were described fully in the article mentioned, and need not be recapitulated here.

[4]See *Scientific American Supplement*, No. 2187.

[5]The number of truncated flakes removed from the edge of a flint was shown to indicate whether the specimen had been flaked by man or by nature. See *Science Progress*, July, 1916, pp. 46-7.

War time Diet and Health

By Percy G. Stiles, Harvard Medical School

At a time when the problem of domestic food supply is peculiarly pressing and when dietetic habits are undergoing enforced changes, the question must be frequently asked whether there is any widespread danger to health in these conditions. Any one attempting to answer it must recognize at once that an economic consideration has to be admitted. Rising prices, unless offset by rising wages, must make for malnutrition among the poor. The purpose of the present inquiry is to attend more particularly to those in better circumstances who are able to pay the cost of the staple foods but who are making unwonted substitutions.

Established habits in the choice of food are not very readily changed. When a new dietary is adopted in opposition to the dictates of appetite and pursued under protest, an unconscious reduction of intake may be expected. Some loss of weight may follow, but equilibrium at a new level will ordinarily be established. Few of us have discerned the simple principle to which Doctor Lusk has lately called attention; that we can be large people, maintained by large rations, or much smaller people with a much lighter requirement. Whether the reduction is to be desired or not depends on the original condition. For a considerable fraction of the adult population, weight reduction is calculated to add to the expectation of life.

Our food serves a constructive purpose, but this is the function of but a small part of the total income. A far greater proportion is utilized as fuel to support muscular activity. The maintenance of the body temperature is secured by the oxidation of food material, and it may be suggested that the sedentary individual conserves food when he avoids exposure to cold. If it becomes necessary to save food and coal at the same time the importance of dressing warmly is obvious.

To keep the living tissues in good condition certain chemical compounds—amino-acids, "vitamines," and mineral salts—are indispensable. These specific needs are more surely met when the diet is varied and inclusive than when it is monotonous. This is a teaching which has been greatly emphasized in the past few years. Without questioning the principle, we may still rest assured that the average citizen is in little danger of wrecking his health by the omission of particular "building-stones" from his daily supply.

Among the fuel foods a great deal of substitution seems practicable. To do without cane-sugar is a galling annoyance; more because it deprives us of so many attractive dishes than by reason of any peculiar merit in sugar itself. It is only in recent times that this product has become an important item in the food of the nation. (Nevertheless it had come to furnish something like one-seventh of the total energy of our people. Its replacement is an operation of vast magnitude.)

Are there any groups deserving special consideration and liberal treatment? At once we think of our soldiers and sailors. We should place in the same class all those whose manual labor and exposure are equally severe. We must, in addition, recognize the high nutritional requirement of childhood and youth. Doctor Gephart's study of the food furnished to the boys of St. Paul's School, Concord, N. H., is suggestive. The allowance to each pupil was found to be greater than that of a hard-working farmer. In spite of this, the average student bought refreshments between meals to an amount which added about fifteen per cent to the regular diet. Since the boys were not overweight we can not say that they took any more food than their active systems required.

When, as at present the public conscience is awake, and people everywhere are concerned to know their patriotic duty, individuals may impose upon themselves extreme and ill-advised denials. In such cases health may suffer. These men and women need to be set right in their practice just as truly as do those who are selfishly indifferent to the exigency. They must endeavor to conserve their own capacity for service and not solely the nation's food.

We need particularly to cultivate a right mental attitude toward the situation. It is within our power to determine whether we will magnify our privations or find an intellectual pleasure in grasping the problem and watching the process of its solution. We may dwell on the unwelcome restrictions or we may with greater advantage rejoice in the new spirit of cooperation.—*The Health News*, issued by the New York State Department of Health.

The Sikhs*—I

A Sect That Became a Nation

By Sirdar Daljit Singh, C.S.I., Member of the Council of the Secretary of State for India

It is a very big and difficult task to tell in one paper all about such "a singular nation," as Sir John Malcolm calls the Sikhs, the origin of their religion, the religion itself, the lives of the ten Gurus who contributed to found it, the growth and history of the Sikh kingdom, its wars and constitution, and the part this people has played in the history of the Indian Empire down to the present day. I shall, therefore, make no attempt to say anything in detail, or to discuss anything.

A RELIGIOUS BODY

"Sikhs are excellent fighters." In these four words one may sum up all that is generally known of the Sikh people. But it is not the essential fact about them. They are, in the first place, devout disciples of a religious teacher, who in the process of evolution was the latest and most enlightened given to India. It was this circumtsance, coupled with the true religious spirit of self-sacrifice aroused later by the tenth or last of their Gurus, that turned almost the whole sect into a nation. "Disciple" is the meaning of the name they bear. Perhaps there could not be a better word than this. Customs, ceremonials, social and other laws had become so predominant a feature in almost all the religions of the time that the spirit was lost in form and had created barriers, even on the spiritual plane, that separate man from man and race from race. The very word Sikh is itself a symbol of self-surrender, giving at once an idea that religion is not a thing of outside world, but of heart, and not of form but of soul. The Sikhs consist, in fact, of two classes: (a) Peace-loving believers, to whom the name was first applied, and who are ignorantly grouped with the nebulous mass of Hinduism: and (b) the warriors properly called "Singhs," a word meaning lions. The former constitute the field of recruitment for the latter. So vital is the religious spirit among them that one cannot become a Singh unless one receives a special baptism, called the *pahul;* and there is equally a form of baptism for the Sikh, known as Charan Ghal. Moreover, all who receive baptism, whether Aryans or aborigines, spiritual Brahmans or low-class "Shudras," Indians or foreigners, are alike admissible, and henceforth treat each other as members of the same family.

NUMBERS AND OCCUPATION

It is difficult to estimate their exact number. Census reports put them at about 2,500,000, but take account of Singhs only. If we add those Sikhs who are classed as Hindus, the number must probably be doubled. The occupation of the Sikhs is, generally speaking, either the sword or the plough. It is a curious fact, and as old as the use of arms in India, that agriculture has always been held to be the proper means of livelihood of the warrior, and that from the best agriculturists the finest soldiers have always been drawn. Three-fourths of the Sikh population are tillers of the soil, and perhaps the best in India. In their proper home, the Punjab, they own nearly one-fourth of the cultivated land. Self-respecting and sentimental, the Sikh is a most willing and hard-working husbandman; and he is equally enterprising. He will go to any part of the world where he can find good labor; and so he is to be met with not only in the other Indian provinces, but in Afghanistan, China, Southern Asia, and America. Yet, wherever he may be, and whatever he may be doing, the Sikh cannot forget his sword and the spiritual tradition of his forefathers. The first sound of a call to arms will stir anew in him the spirit infused by his spiritual father, Guru Govind Singh, and find him ready to maintain that tradition at the cost of his life.

NUMBER IN THE ARMY.

In normal times one-fourth of the Indian Army consists of Sikhs, and they have been described by such masters of the military art as Lord Roberts and Kitchener, and regarded by the whole administration of His Imperial Majesty, as the flower of the Indian fighting forces. Sir Lepel Griffin said: "The Sikh is always the same; in peace, in war, in barracks or in the field, ever genial, good-tempered and uncomplaining; a fair horseman, a stubborn infantry soldier, as steady under fire as he is eager for a charge. Hardy, brave, and of intelligence too slow to understand when he is beaten, obedient to discipline, devotedly attached to his officers, he is unsurpassed as a soldier in the East.

EARLY CONFLICTS

The period from the middle of the fourteenth to the middle of the fifteenth centuries of the Christian era was remarkable, in the East as in the West, for political and mental upheavals, and for that religious and social awakening which always follows a time of storm. In Europe the Mohammedans had conquered Turkey and Greece, and had penetrated into Thrace and Hungary; in Asia Taimur had spread his kingdom from Siberia to the Arabian Sea, and from the Ganges to the Hellespont. There had been many wars and some great discoveries. For Europe the struggles of Luther and Calvin heralded the dawn of a new age of reform and reconstruction; and in India the monotheistic but quiescent teachings of saints like Kabir and Ramanand began to loose the fetters of superstition and priestcraft. The Punjab was a principal scene of conflict. Now known as the spearhead of the Indian Empire, it lay in the path of every invader; and in the fourteenth century frequent disturbance and bloodshed had lowered the moral standard and left a state of confusion. The fruit of this sowing began to be reaped in the century that followed. The third day of the light half of the month of Baisakh (April-May) in the year 1469 A. D. is the first day of the history of the Sikhs. On that day the founder of the religion, Guru Nanak, was born at Talwandi, now called Nankana after the Guru's name, in the district of Lahore.

It is important to mark the significance of this event, and for that purpose to realize the state of society in which his teaching was to come as a new and great moral impulse, being distinct from any that had preceded it and singularly modern in certain aspects. The ancient "Dharma"—for religion is no appropriate name for it—had included all that is meant by duty and law as well as worship, from the most ordinary obligations of society and the household, sanitary precautions, customs and ceremonial rites to the national ideal, and from art, literature and daily prayers for the common human wants to the highest philosophy of the Vedanta. Such a system looks grand, nothing could be finer. But it is reduced to practice with difficulty, and the difficulty of adapting such a system to all times and civilizations is still greater. Nor could the religion of the invaders at once command sympathy. The need was keenly felt in the Punjab for a religion that should be simple, pure, and free of superstitions and dogmas based on morality; and this it was left for Guru Nanak to found.

GURU NANAK

Guru Nanak was the only son of his parents, Baba Kalu and Tripta. Kalu, a Hindu and by caste a Kshattriya, held the respectable post of accountant in his village of Talwandi. Guru Nanak promised preternatural gravity from his childhood; and his retiring and meditative temperament, indifferent to the petty life around him, was a constant cause of anxiety. Trying to turn the channel of his thought, Kalu once gave him a sum of money and advised him to go to town and buy something that might be sold at a profit in the village. The future Guru had not gone far on his errand when he met a party of faqirs whom extreme hunger had deprived of the power of speech. He hurried to obtain provisions and feed the dying faqirs. The money that had been intended for some bargain was all bestowed in this work of mercy and compassion; and, when questioned by his father, Nanak said: "No bargain could be better than I made, for it is with God, not to perish with this body but to be reaped in the world to come." Kalu's anxiety continued, and he got Nanak married at the age of sixteen. When this availed nothing, he sent him to his only sister, Nanki by name, who was devoted to him, and whose husband, Jai Ram, procured employment for him under the Sultan Doulat Khan Lodhi. In vain. The Guru did his duties honestly, but he spent his leisure in the company of holy men or in deep reflection. At the age of about thirty-four, being then the father of two sons (Sri Chand and Lakhmi Das), and being a man of ripe experience and thought, knowing what it was that he had wanted, Nanak began to preach his gospel. He made four great tours in doing so. Two of them were within the boundaries of India, embracing all parts of it from Karachi to Assam and from Kashmir to Cape Camorin. The others covered Tartary, Turkey, Arabia, Afghanistan, Kandahar and Tibet, with Ceylon and some of the southern islands; and in most of these countries devoted disciples of the master are still found. It is characteristic that in these journeyings he was accompanied by his first disciples, Mardana, the musician, and Bala, who were so inseparably his associates that in all old paintings of the Guru they are included. Mardana was formerly a Musalman and Bala a Hindu Jât. Music took a conspicuous part in his life, his devotions and his meditations; and it is essential to the Sikh worship. In his later days, completing a long life of devoted effort, he settled down with his family near Batala, on the banks of the Ravi, one of the "five rivers" of the Punjab, and there expounded his doctrine to thousands who came to him. There, too, he devised and consecrated rites of morning song and evensong—rites of singular beauty and the most poetic appeal. Imagine the daily scene. Immediately before the sun appeared at dawn, the morning song was intoned by a reverent host. It preceded the service, as if invoking the Spiritual Sun to shed His rays and illumine the darkest chambers of the heart; and so, as the light came, it inspired a glad uprising of the spirit. At nightfall, again, when the sun's last beam was withdrawn, the hymn of the Reh Ras—the Right Path—moved the worshippers to inward contemplation. There, in 1538, the Blessed One passed away. That he was revered by Hindus and Mohammedans alike is plain from the fact that the sheet which covered his body at the time of his passing—for there was only the sheet left to them, the body not being found—was divided between these adherents, the one half to be buried by the Mohammedans and the other burnt by the Hindus according to their respective customs.

HIS UNIQUE TEACHING

What were the distinctive features of this great teacher's gospel? Where we find a purely spiritual religion, it must always be difficult to distinguish it from others and to discriminate between them, for, after all, the truth is universal, and that which is not essential everywhere is not true. Guru Nanak taught that there is nothing higher or better, nothing more exalting, nothing more peaceful, nothing more full of joy and bliss, than to love God and to surrender oneself to Him by devotion.

"Sing and hear and put His love into your hearts:
So shall your sorrows be assuaged, and ye be absorbed in Him, who is the abode of happiness."

Of God he said: "He is one, His name is true, He is the Creator, the Primordial Being, devoid of fear and enmity, timeless, unborn, self-existent." These are universal truths. But there were important respects in which the Master's teaching was unique in India. In the first place, unlike the saints who had preceded him, he taught that good men were not to withdraw themselves from the world as the faqirs did, or to shirk those duties which Nature had laid upon them, but were so to live in the world, "as a lotus in water," that their virtue should subdue the evil in it, and, by "losing self in the Universal Self," transform the world's misery into happiness. Then, distinctively from Hinduism, he prohibited all kinds of worship except that of the Absolute, the Dweller in All Beings, and preached the equality of men, abolishing the caste system and founding a democratic brotherhood. He held that the true way of self-surrender is in service done to others, and that the key to all such service is a pure and high morality. Living the good life, men were to love the world because it is God's, and to love each other because God is in all men and they in Him. Ceremonies, laws and customs, he said, are the expression of passing phases of the human mind. He saw that they cannot suit the changing conditions and civilizations of different ages and that they are valuable only as they declare at any time the pure moral law. The form is always changing, the spirit is eternal. This highest axiom of philosophy he found applicable to daily life; for, as the moral law, devotion and the selfless life are alone matters of

*Abstracts from a paper read before the Royal Society of Arts, and published in the Journal of the Society.

the spirit, he regarded everything else as form, and, therefore, as liable to change according to the needs of the time. I think you will agree that there was something very remarkably modern and great in this outlook, something at once noble and practical, destined to affect India profoundly if it could prevail.

SOME SAYINGS OF THE MASTER

You will wish to hear some of the sayings of such a teacher, and of the stories told of him, recorded by his immediate successor. When he was seven years of age his father, Kalu, wished to celebrate the ceremony of investing him with the sacred thread of the Hindus, which can be worn by three higher castes only. In the midst of an assembly of relatives and friends, and in presence of the great Brahmin priests, he caused astonishment by refusing to wear the knotted thread of cotton, which was perishable and served no purpose. His protest is chronicled in verse, which I translate:

Let the staple of your life be mercy, spun into a thread by contentment, strengthened by truthfulness, knotted by self-control.

Such a thread is needed for the soul, O priest: if you have such a one, invest me with that.

The saying lays down the four cardinal virtues that Nanak preached, "without which life is in vain" and "devotion impossible." There is a story that illustrates both his attitude to caste observances and his thought of right living. When staying in Emnahad at the house of a disciple called Lalo, a carpenter, he declined the hospitality of one Malik Bhago, the governor of the place. Insisting, the governor remarked that his food was surely better than that of a man of lower caste: but the Guru, with his usual calmness, replied that on the contrary the carpenter's food was much the purer, for it was rightly earned, while the Malik's was no better than blood sucked from the poor. His preaching may be illustrated by two quotations (sayings addressed to Mohammedans and Hindus respectively). To Mohammedans he said on one occasion:

Make kindness thy mosque, sincerity thy prayer carpet, what is just and lawful thy Koran,
Modesty thy circumcision, civility thy fasting; so shalt thou be a Musalman.
Make right conduct thy kaaba, truth thy spiritual guide, good works thy creed and thy prayer,
The will of God thy way, and God will promote thine honor.

When invited to share the worship of the Hindus at Jaggannath, he declared a purer sense of ritual and a disdain of idolatry in this hymn:

The sun and moon, O Lord, are Thy lamps; the firmament thy salver, the orbs of the stars the pearls enchased in it.

The perfume of the sandal is Thine incense, the wind is Thy fan, all the forests are Thy flowers, O Lord of light.

What worship is this, O Thou Destroyer of birth? Unbeaten strains of ecstasy are the trumpets of Thy worship.

Thou hast a thousand eyes and yet not one eye; Thou hast a thousand forms and yet not one form;

Thou hast a thousand stainless feet and yet not one foot; thou hast a thousand organs of smell and yet not one organ. I am fascinated by this play of Thine.

The light which is in everything is Thine, O Lord of light; from its brilliancy everything is brilliant.

By the Guru's teaching the light becometh manifest.

What pleaseth Thee is the *real* worship.

O God, my mind is fascinated by Thy lotus feet as the bee with the flower: night and day I thirst for them.

Give the water of Thy favor to the sarang Nanak, so that he may dwell in Thy name.

Before his passing away, and while in perfect health, the Guru selected his successor, a recent convert whose devotion and fidelity he had quietly marked; and by this choice he was the first Indian teacher to honor the fittest without respect to rank or parentage.

THE GURU SUCCESSION

A saintly line of Gurus, making ten in all, watched over and guided the development of the new religion, which presently declared against such specific errors and was sharply defined by events. Space and time being too short, I cannot dwell on the lives and sayings of each one of these; I can only try to show how far, besides imparting spiritual instruction as they followed in the footsteps of their Master, they affected the social, political and literary world around them. The religion owed to Guru Angad, the first of them, the invention of the Gurmukhi character, which has proved to be best suited for the Punjabi language. The first book that its inventor wrote in this script was the life of the Blessed One, from the lips of Nanak's lifelong companion Bala. The third Guru, Amar Das, forbade suttee and upheld the marriage of widows, reforms that make a landmark in Indian history. To the fourth, Guru Ram Das, the Moghul Emperor Akbar gave that piece of land at Amritsar, "the Pool of Immortality," where now stands the Golden Temple, the Mecca of the Sikhs. The fifth of the line, Guru Arjan, compiled the Granth, the sacred book of the Sikhs, enshrining the sayings of himself and his predecessors; which to this day both serves and is respected as "the living Guru" for purposes of spiritual teaching. He was a great supporter of education, and from him emanated the system of primary education in the form of "Dharamsalas" dealt with later on. So far, there was no hint of a warlike spirit in the new religion.

NATIONALITY

But at this time the Moghul rulers began to show signs of a different policy, and the gulf between the ruler and the ruled had widened to its full width, into the details of which I need not enter, but which led the sixth Guru, Har Govind, to take up arms; and it was now that, under the stress of events, the latent spirit of nationality first awoke, and peace-loving men began to change into a militant race. The spiritual leadership was continued by the Gurus Har Rai, Har kisan, and Tegh Bahadur; and it was not until the days of the famous tenth Guru, Govind Singh, that the Singh warrior class was constituted.

A GREAT MARTYRDOM

Guru Govind Singh was the son of Tegh Bahadur, whose martyrdom directly furnished the motive for that development. The Emperor Aurangzeb had required that the Hindus of Kashmir should embrace his own faith, and had been answered that they would be guided by Guru Tegh Bahadur. The Guru was at once summoned to Delhi. He knew that he must sacrifice himself to save them; but, wishing before his departure to test his son, then nearing his majority at fifteen, and to see if he had the true temper of a leader and successor, he asked Govind what he thought. The boy answered, nobly, that there could be nothing better than such a sacrifice, and the Guru set out for Delhi with a light heart, satisfied. At Delhi two memorable things befell. One was the utterance of a remarkable prophecy, which was to knit a close tie between the Sikh people and the English when it was remembered long after. The Guru, as he stood one day on the roof of the house where he had been lodged, was accused of gazing at the harem of the Qazi across the way. He answered: "I look towards the West"; and, when asked what he meant by this, he said: "I do so, because it is from the West that a people must come, a nation of men wearing hats on their heads, who shall bring with them justice, prosperity and peace." The other event was his death, the manner of which was very striking. A miracle had been demanded in proof of his claim to be a divine teacher, and he had declined that test; but, being imprisoned now and sick of daily torture, he said, "I will show you a miracle." In the presence of the Emperor he wrote some words upon a sheet of paper, folded it, tied it with a thread round his neck, and then bade them bring the executioner with his sharpest sword to behead him. His head fell, severed at once from the body. But what he had written was these words: "I give my head but not my religion." The superbly ironic miracle was a portent. Estranged once for all, the Sikhs under Govind Singh, and later on under different warrior leaders, were committed in defense of the faith to form their nation and to break the power.

[TO BE CONTINUED]

Action of Hydrogen Peroxide on the Neutral Salts of Lead

NEUTRAL lead salts exert a more or less marked catalytic action on hydrogen peroxide (100 vols.), the catalysis being intense with soluble organic salts and feeble with insoluble organic salts or mineral salts. With a salt such as lead acetate the ultimate result is the complete decomposition of the hydrogen peroxide, and the lead acetate contains no residual lead peroxide.—Note in *J. Soc. Chem. Ind.*, on a paper by V. ZOTIER in *Bull. Soc. Chim.*

A Substitute for Celluloid

SOME time ago it was announced that a successful incombustible substitute for celluloid, manufactured from soya bean cake, had been discovered in Japan. Further particulars of the new product have come to hand. It is called "Satolite," after the inventor, Professor Sato. Satolite is a galalith made of the glucine of soya bean, coagulated by formalin. It is said to be produced much more cheaply than ordinary celluloid, and to have several advantages for industrial use not possessed by the latter.

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